





Page 1

11/1/11



~~Ca 9.1~~

Cc 7.1

R32645

A GUIDE  
TO THE  
MICROSCOPICAL EXAMINATION  
OF  
DRINKING WATER



A GUIDE  
TO THE  
MICROSCOPICAL EXAMINATION  
OF  
DRINKING WATER

BY  
J. D. MACDONALD, M.D., R.N., F.R.S.

DEPUTY INSPECTOR-GENERAL OF HOSPITALS AND FLEETS.  
ASSISTANT PROFESSOR OF NAVAL HYGIENE, ARMY MEDICAL SCHOOL.

WITH TWENTY-FOUR LITHOGRAPHIC PLATES.



LONDON  
J. & A. CHURCHILL, NEW BURLINGTON STREET  
1875

LONDON:  
SAVILL, EDWARDS AND CO., PRINTERS, CHANDOS STREET  
COVENT GARDEN.



TO

SIR ALEXANDER ARMSTRONG, K.C.B., LL.D., F.R.S.

ETC. ETC. ETC.

DIRECTOR-GENERAL OF THE MEDICAL DEPARTMENT OF THE NAVY,

WHOSE NAME IS ESPECIALLY ASSOCIATED WITH THE CULTIVATION OF

THE SCIENCE OF HYGIENE IN HER MAJESTY'S NAVAL SERVICE,

*This Work is Inscribed*

WITH FEELINGS OF RESPECT AND ESTEEM,

BY HIS MOST OBEDIENT SERVANT,

THE AUTHOR.



## P R E F A C E.

---

OFFICERS OF HEALTH, as well as Naval and Military Medical Officers, have often to determine the nature of the suspended matters in water used for drinking. In an Hygienic point of view, the import of these suspended matters must vary with their properties, whether mechanical, chemical, or vital.

Mineral particles may affect health, on account of their mechanical action, as for example, when mineral silt of clay, or fine sand causes diarrhœa. Dead animal and vegetable substances may have more important effects, as, when suspended faecal matter produces irritation of the whole alimentary tract. On the other hand, living things, such as the ova of Entozoa, the nematoid worms, and small leeches may give rise at once to certain grave disorders, or Algæ may act on sulphates, and disengage sulphuretted hydrogen. There are, however, numerous living creatures, both animal and vegetable, found in drinking water, to which no special effect on health can be at present assigned; they may be important only as showing the presence of organic impurities, which serve as their pabulum, or as indicating putrefaction. Farther observation may, nevertheless, prove them to be of deeper sanitary significance, and

even now, though there is no good evidence of their hurtful action, no one would hesitate to condemn a water containing Bacteria or fungi, or swarming with the lower forms of life. At any rate, whatever may be the conclusions hereafter arrived at, as to the sanitary import of the innumerable suspended matters, it cannot be doubted that Medical Officers of Health should be able to state what they are. This must be done chiefly by the microscope; but, as it is often difficult for those who are unacquainted with Natural History, even with a voluminous work of reference in their hands, to determine the nature of the various objects that may present themselves, the design of the following synopsis is to furnish a number of figures of those objects, with such a commentary as may enable them to be identified. No attempt has been made to link particular forms with special effects; it is doubtful indeed, if this be possible at present, beyond a limited extent, being rather a point for the enquiry of future times, which this little work can merely purport to aid.

The Tables and figures may also prove useful to young naturalists, who are beginning to investigate the world of waters, that wonderful world, in a single drop of which we may behold varieties of form, almost as numerous as those upon the surface of the great globe itself. Many books have been published with a similar object in view; but one more may find a place, to facilitate the study of a very interesting department of Natural Science.

In reference to the Plates, by way of apology, it may be mentioned that, with the view of lessening the expense of



publication, the figures have been drawn with pen and ink, but, though they cannot pretend to the fineness and delicacy of steel engravings, some artistic effect has been preserved, and it is hoped that they will answer, equally well, the purpose for which they are intended.

To Professor Parkes, F.R.S., the thanks of the author are especially due, for his valuable advice and guidance, in rendering the treatment of the subject as practical as possible.

WESTON GROVE ROAD,  
WOOLSTON, SOUTHAMPTON,  
*October 1st, 1875.*



## CONTENTS.

---

INTRODUCTION.—MODE OF COLLECTING SEDIMENTS AND PLACING THEM UNDER THE MICROSCOPE.—MICRO- SCOPICAL POWERS.—IMMERSION-LENSES.—CAUSES OF DISCOLORATION AND TURBIDITY . . . . .	1
SECTION I.—MINERAL MATTER . . . . .	4
SECTION II.—DEAD ORGANIC MATTER . . . . .	6
A. DEAD VEGETABLE MATTER . . . . .	6
B. DEAD ANIMAL MATTER . . . . .	7
SECTION III.—LIVING FORMS . . . . .	9
A. LIVING PLANTS . . . . .	11
B. LIVING ANIMALS . . . . .	34

N.B.—*The numerals placed opposite the genera indicate the corresponding figures in the Plates.*





## ERRATUM

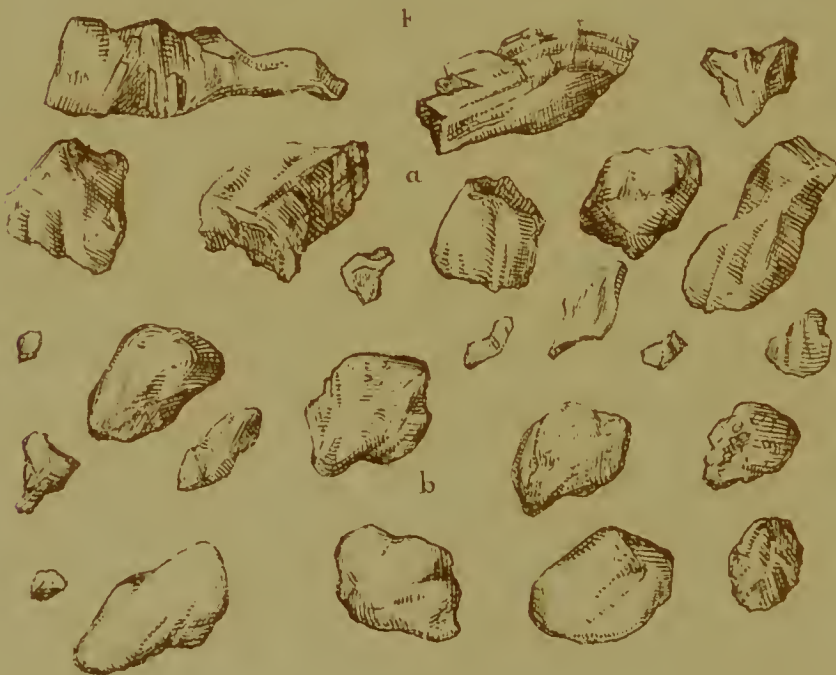
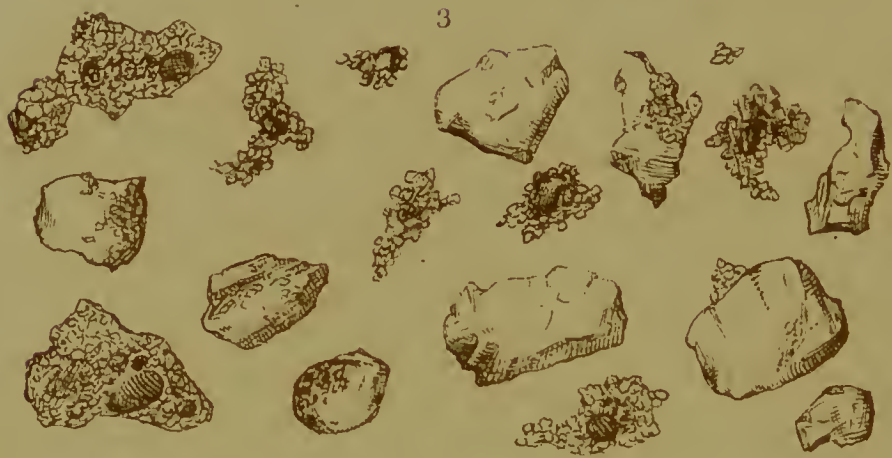
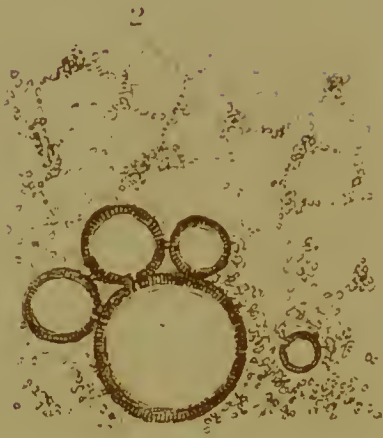
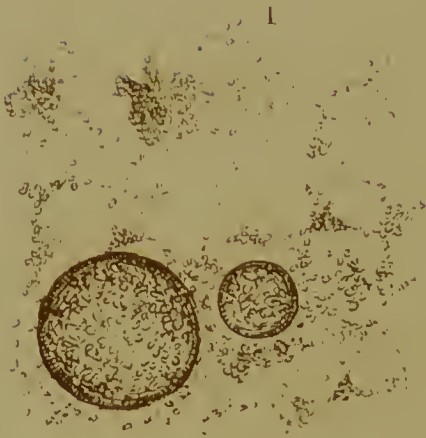
---

Page 42 *to end*.—(Plate XIV.) *should be* (Plate XV.),  
(Plate XV.) *should be* (Plate XVI.), and so on.





# MINERAL MATTER.





## PLATE I.

### *Mineral Matter.*

1. Carbonate of lime, finely divided with vesicles of atmospheric air, between the glass slip and cover.

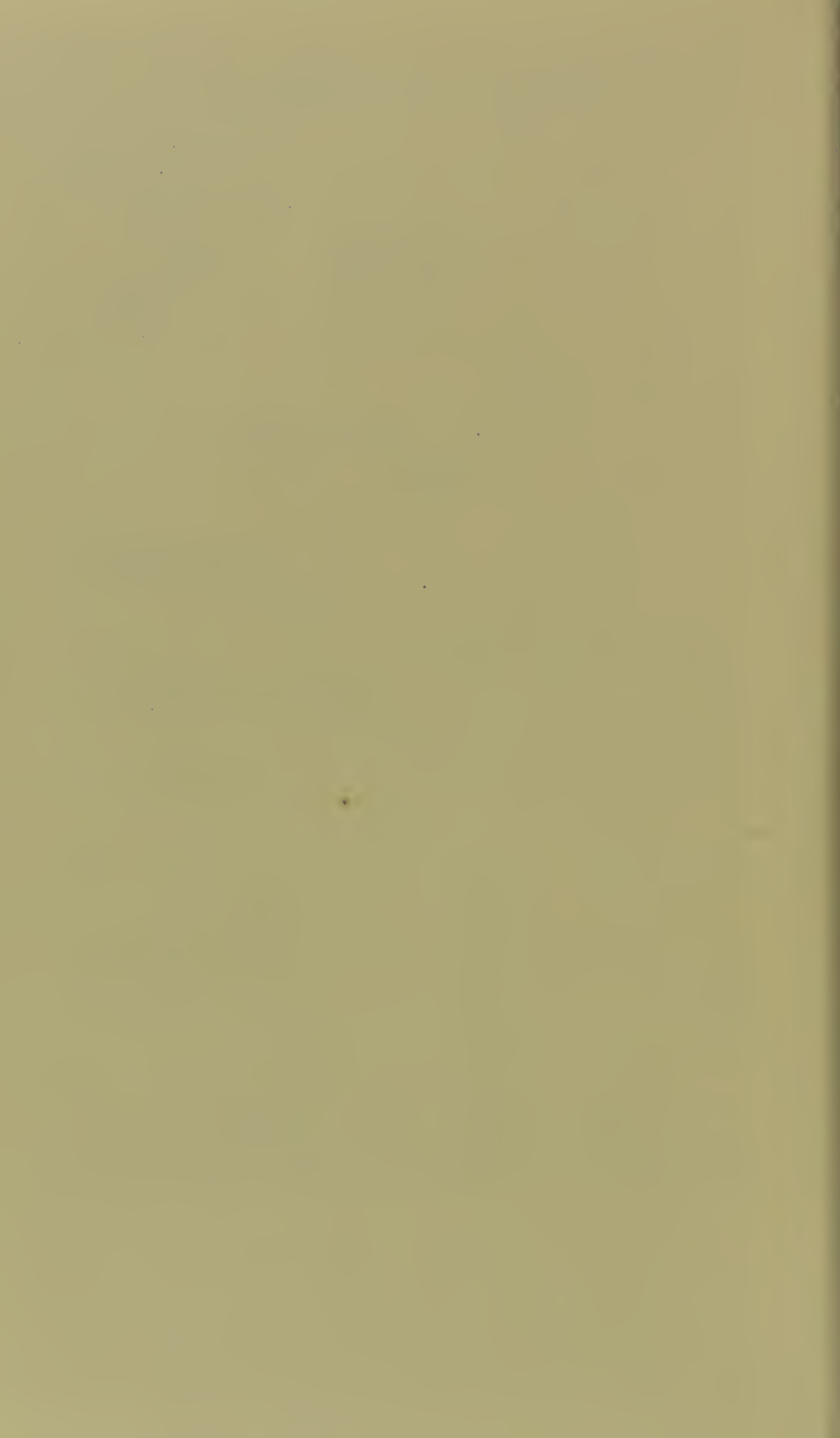
2. Also carbonate of lime, but with the evolution of carbonic acid gas by the addition of an acid.

3. Fine green mineral particles, cohering as a microscopic breccia, or conglomerate, are here and there mingled with larger and probably more recent sandy granules, preserving their angularity and roughness from fracture; taken from the débris of a well-sinking, at the Royal Victoria Hospital, Netley.

4. Silicious or flinty granules taken from road-side streamlets, (*a*) more recent, and (*b*) of earlier date, having been rounded off and smoothed by rolling and attrition, like microscopic boulders.



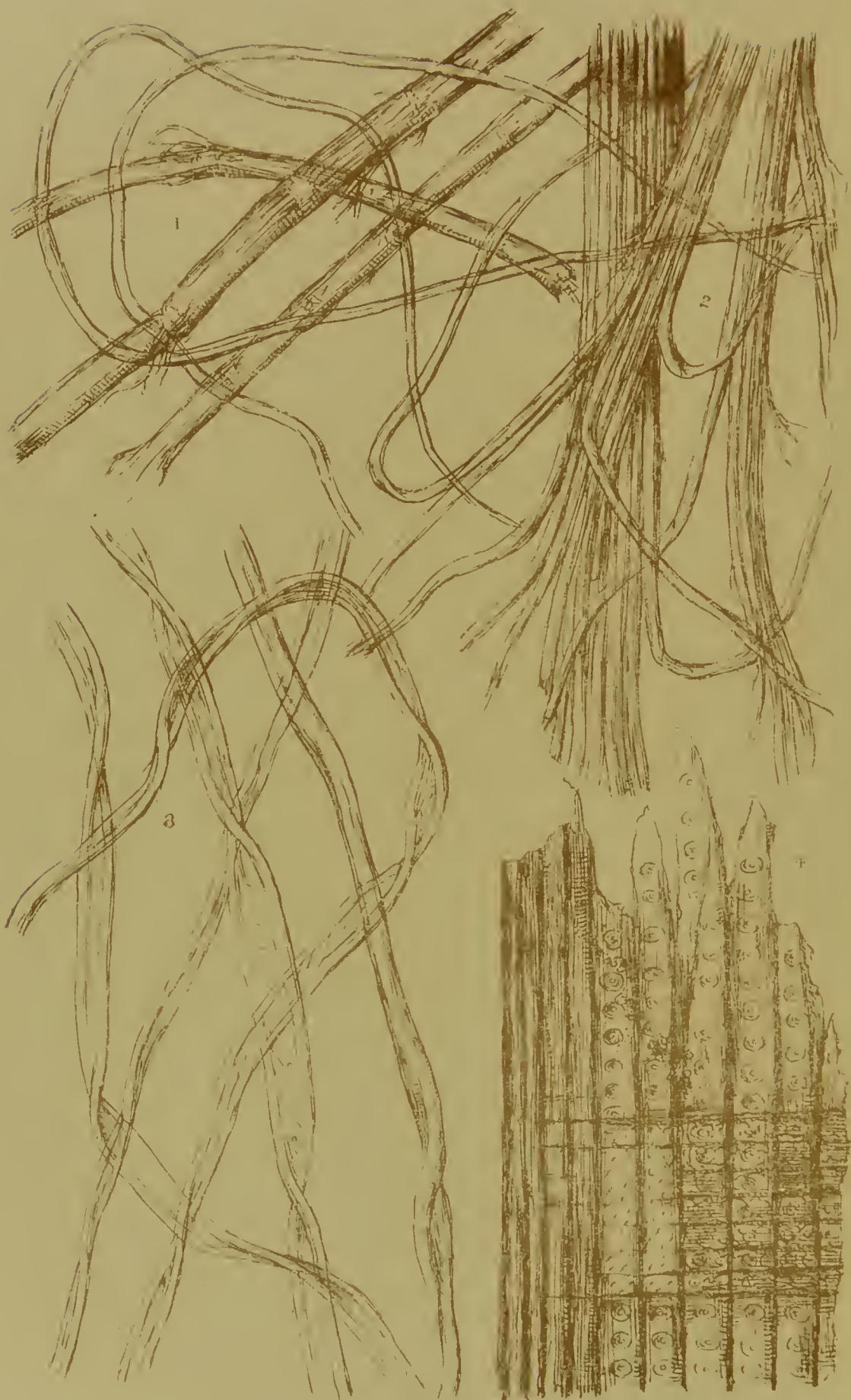








VEGETABLE PRODUCTS.



### PLATE III.

*Vegetable Products indicative of Contamination with  
House Refuse.*

1. Linen fibre.

2. Hemp.

3. Cotton.

5. Chip of deal or pine, with the so-called discoidal tissue,  
and the silver grain of carpenters passing at right angles to  
the woody fibres.







# ANIMAL PRODUCTS.



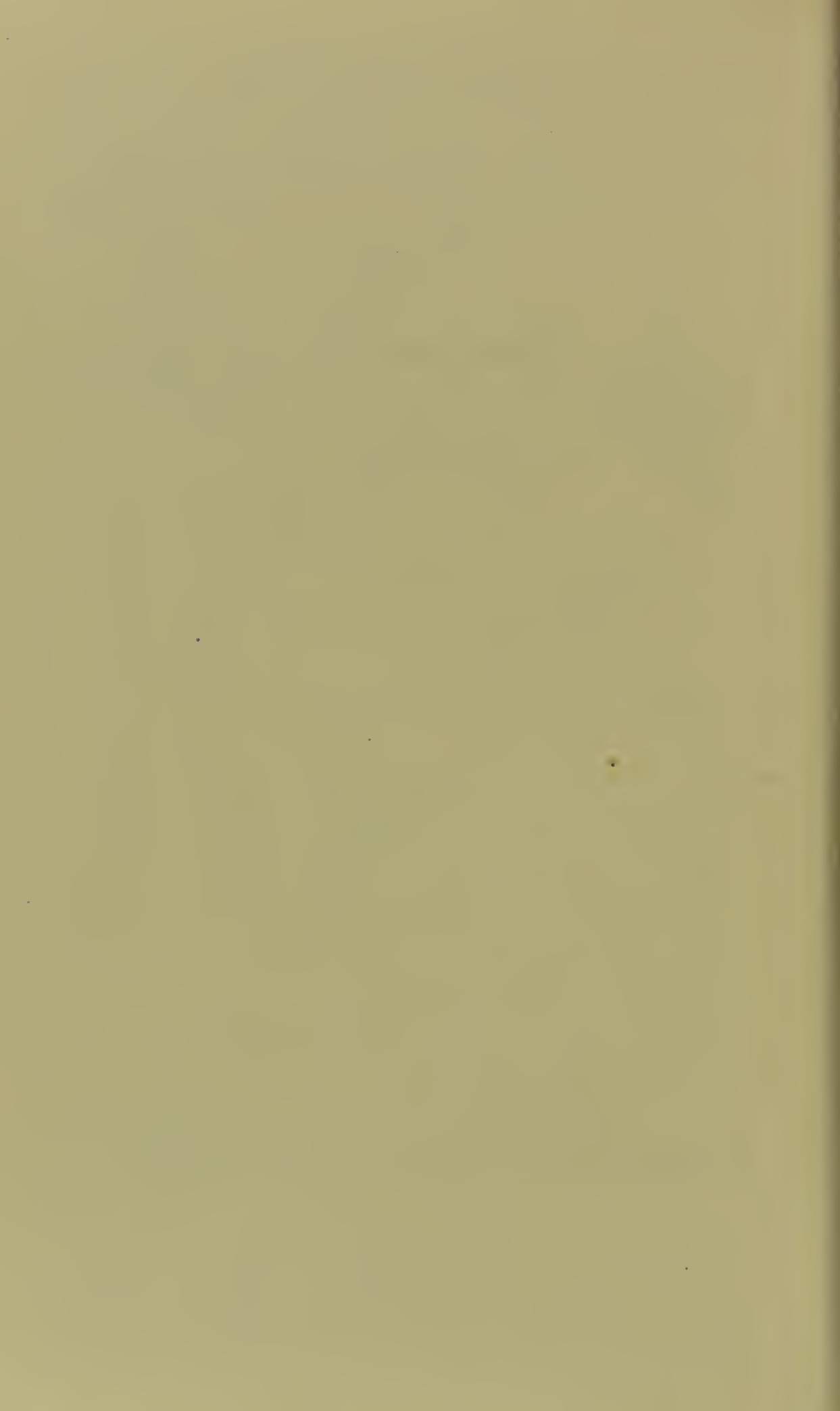
## PLATE IV.

### *Animal Products.*

1. (*a*) Ventral hooklet of Nais (a fresh-water annelid); (*b*) liberated ova of the same, often visible when the body of the parent has broken down so as to be indistinguishable.
2. Spiny spicula of *Spongilla laeustris*, (*a*) straight; (*b*) curved.
3. Spicula of *Spongilla fluviatilis*, (*a*) birotulate;\* (*b*) simple.
4. Part of the leg of a Coekroach.
5. Fore leg of Male Dytiseus.
6. Hind leg of *Gyrinus natator*.
7. Foot of a Spider.
8. Tail of *Cyclops quadricornis* (male).
9. Right superior antenna of the same.
10. Inferior antenna of *Daphnia pulex*.
11. Cast skin of *Macrobiotus* (Tardigrada).
12. Head and trophi of Gnat (*Culex*).
13. Portion of the Polypidum of *Plumatella* (Polyzoa).
14. Egg of *Cristatella Mucedo*.

---

\* The corresponding spicules of the Bombay Tank Sponge, *Spongilla Meyeni*, form very good objects for the microscope.





ANIMAL PRODUCTS.



## PLATE V.

### *Animal Products foreign to the Fresh Water.*

1. Fibres of silk.    2. Woollen fibre.    3. Human hair.
4. Rabbit's hair, (*a*) the shaft; (*b*) the apex.
5. Nucateed scale-like epithelium from the mouth, &c.
6. Cuticular epithelium, angular and irregular, without apparent nuclei.
7. Striped muscular fibre.
8. Tip of a feather.
9. Barblets of ditto, more highly magnified.
10. Scales of Insects. Besides the Lepidoptera—namely, the Moths and Butterflies, numerous other insects are furnished with scales. Thus they form a velvety coat on the Anthracidæ and Bombylidæ, but are more distinctly scaly on bodies of many of the Curculionidæ, Melolonthidæ, Clavicornes, Lepismidæ, Poduridæ, and on the wings of the Culicidæ (Siebold).

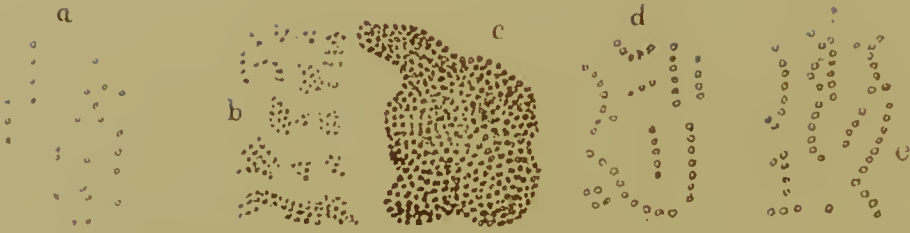






# BACTERIA.

## MICROCOCCUS.



## BACTERIUM.

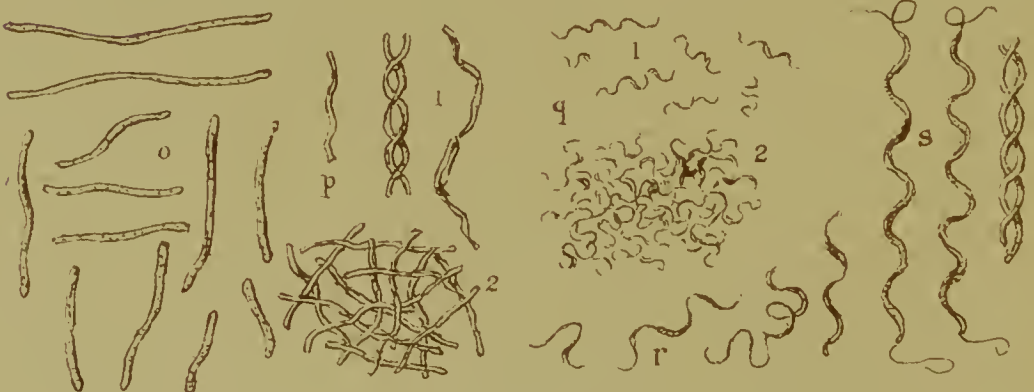


## BACILLUS.



## VIBRIO.

## SPIRILLUM.



## SPIROCHÆTA.



## PLATE VI.

### *Bacteria.*

#### MICROCOCCUS.

- a.* *M. prodigiosus.* *b.* *M. vaccinae.* *c.* *M. crepusculum.*  
*d.* *M. ureae.* *e.* An allied species.

#### BACTERIUM.

- f.* *B. termo*, free. *g.* Ditto in the zooglœa form. *h.* Ditto in linear series.

- l.* *B. lineola*, free. *i.* Ditto in the zooglœa form. *k.* Bacteria with highly refracting point.

#### BACILLUS.

- m.* *B. ulnea.* *n.* *B. subtilis.*

#### VIBRIO.

- o.* *V. rugula.* *p.* *V. serpens*; 1. free, or in twin spirals, 2, felted together.

#### SPIRILLUM.

- q.* *S. tenue*; 1. free, 2. felted together. *r.* *S. undula.*  
*s.* *S. volutans.*

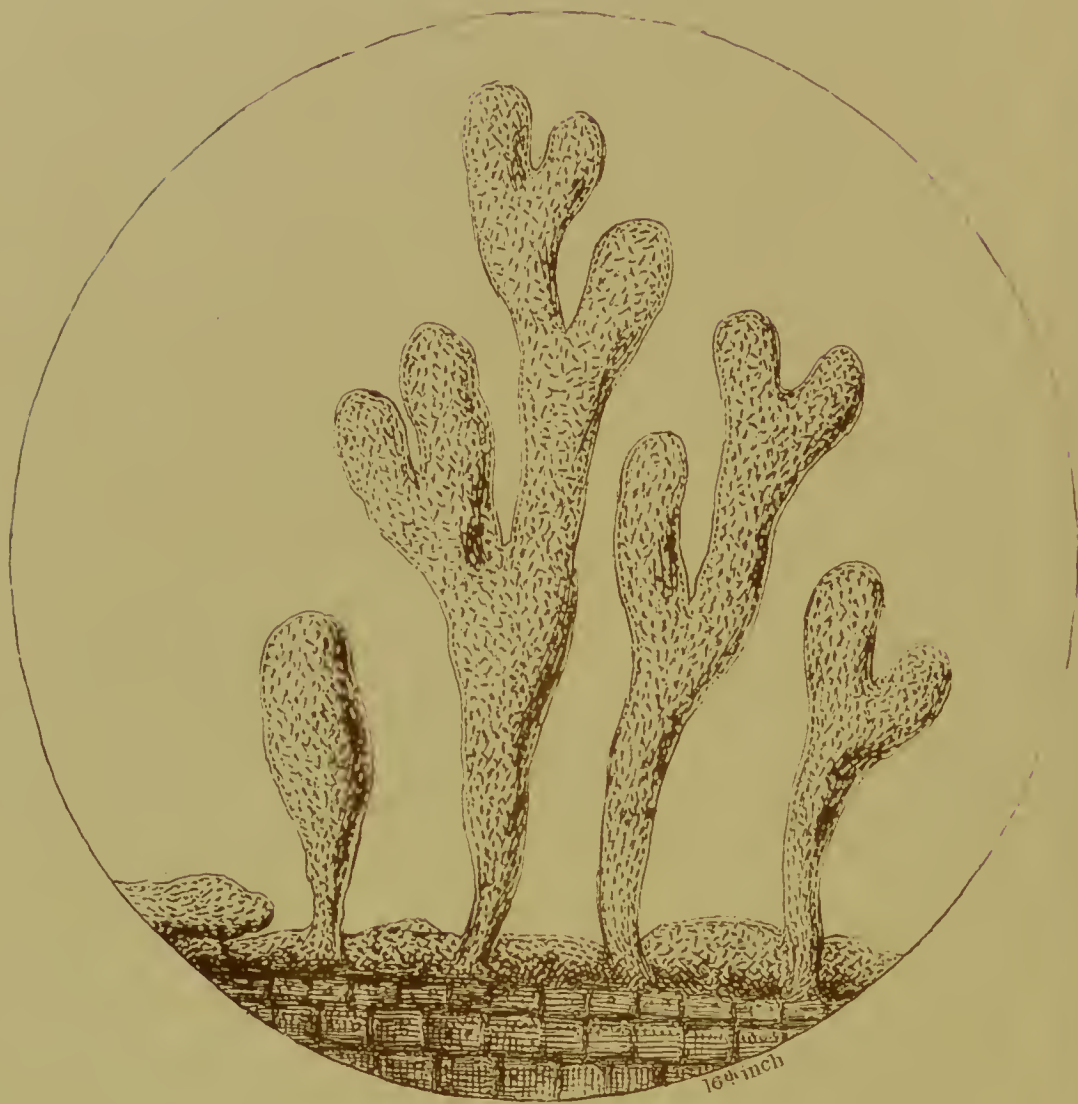
#### SPIROCHÆTA.

- t.* *S. plicatilis.*





# FRONDS WITH BACTERIA.



*Minute Bacteroids in clavate simple or branched fronds on a spray of pond weed.*

## PLATE VII.

### *Fronds with Bacteria.*

This Plate represents exceedingly minute gelatinous fronds, with embedded bacteroids growing upon a decaying portion of pond weed (*Potamogeton*). An encrusting layer is seen at the base from which the little fronds spring.

The great number and extreme minuteness of the molecular forms of vegetable life must still claim the attention of Hygienists, from their possible connexion with certain subtle types of disease, until our knowledge has made sufficient progress, either to accept, or reject them as efficient causes.







# OSCILLATORIACEÆ.



# NOSTOCHACEÆ.



## PLATE VIII.

### *Oscillatoriaceæ.*

1. *Oseillatoria autumnalis* and allied species.
2. *Mierocoleus repens*.
3. *Lyngbya muralis*.
4. *Seytonema Myoerous*.
5. *Rivularia Boryana*.

### *Nostochaceæ.*

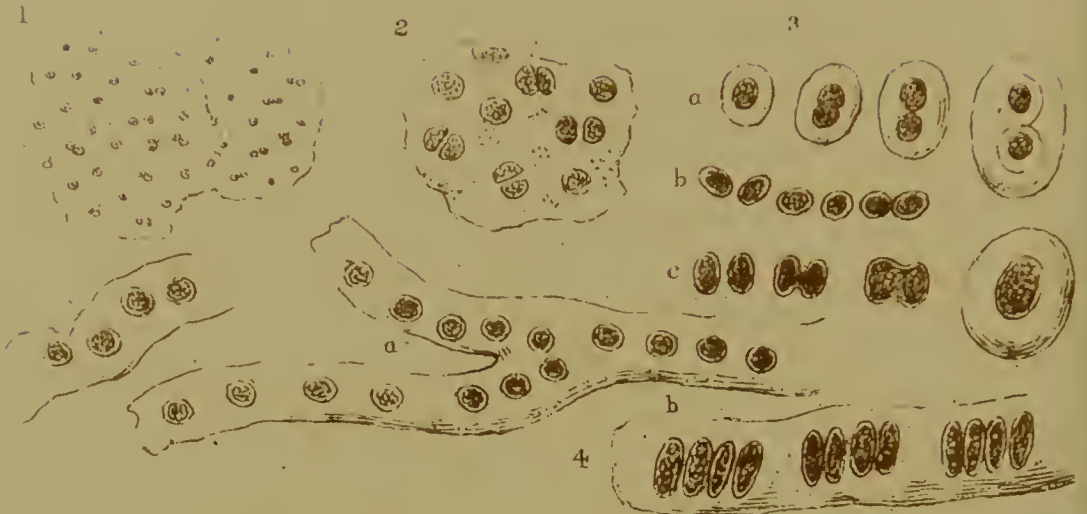
1. *Nostoe commune*. Several fragments showing vesicular cells to the left, and a filament in a gelatinous sheath to the right.

2. *Triehormus musicola*. The longer portion to the left exhibiting spermatic and vesicular cells, and the smaller segments to the right, the effect of treatment with acid.





PALMELLACEÆ.



TYPES OF DESMIDIACEÆ.





## PLATE IX.

### *Palmellaceæ.*

1. *Microhaloa Ichthyoblabe*. 2. *Palmella cruenta*.

3. *Coccochloris Brebissonii*. (*a*) Development and cleavage of a cell resulting in two new cells, each enclosed in a new gelatinous coat within the primary one. (*b*) Multiplication in the absence of the moisture necessary for the production of the gelatinous coat. (*c*) Approximation, union, and coalescence of two endochromes, to form a new cell, with the capability of repeating the process with a similar cell.

4. *Hormospora* (*a*) *mutabilis*, and (*b*) *transversalis*; which latter makes a near approach to some of the humbler *Desmidiaceæ*.

### *Types of Desmidiaceæ.*

1. *Closterium* (*a*) *lunula*, (*b*) *moniliformis*. 2. *Penium Brebissonii*. 3. *Spirotænia condensatum*. 4. *Docidium baculum*. 5. *Tetmemorus Brebissonii*. 6. *Micrasterias* sp. (Fiji.) 7. *Euastrum didelta*. 8. *Cosmarium margaritifera*. 9. *Arthrodesmus convergens*. 10. *Xanthidium fasciculatum*. 11. *Staurostrum gracile*. 12. *Didymocladon furcigerus*. 13. *Didymoprium Grevillii*, (*a*) front, and (*b*) side-view. 14. *Desmidium Swartzii*, (*a*) front, and (*b*) side-view. 15. *Sphærozosma vertebratum*. 16. *Hyalotheca dissilens*. 17. *Aptogonium desmidium*. 18. (*a* and *b*) *Scenedesmus quadricornis*. 19. (*b*) *Scenedesmus obtusus*, (*c*) *S. obliquus*. 20. *Ankistrodesmus falcatus*.





# 34 TYPES OF FRESH WATER DIATOMACEÆ.



## PLATE X.

### *Thirty-four Types of Fresh-Water Diatomaceæ.*

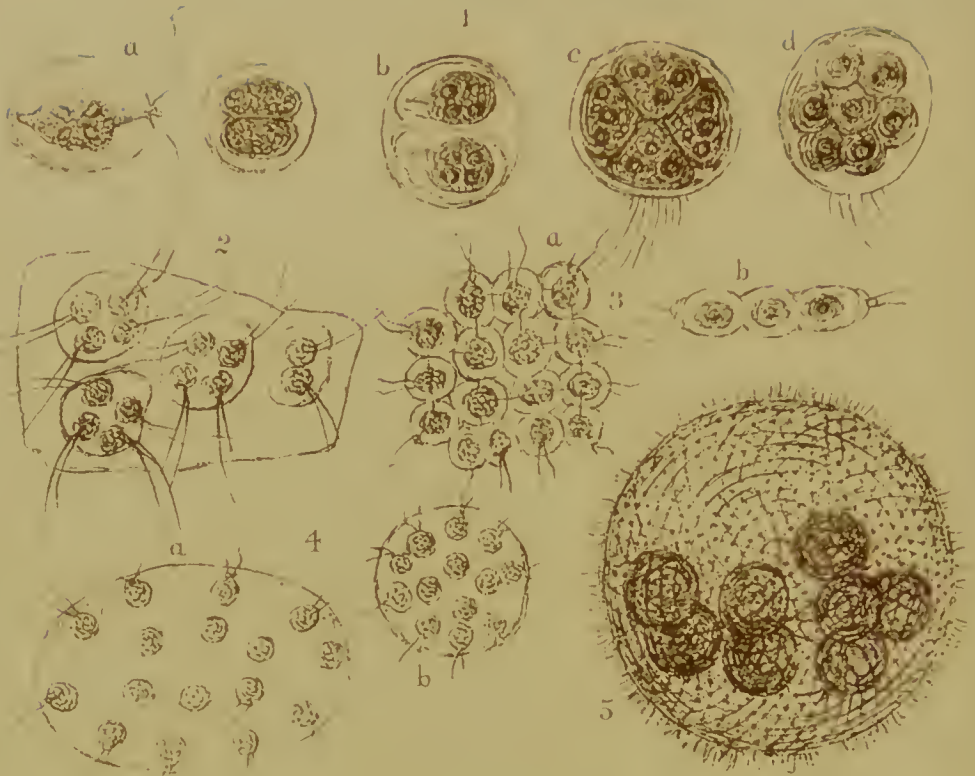
1. *Epithemia turgida*. 2. *Eunotia tetraodon*. 3. *Himantidium pectinale* (*a* side, and *b* front view). 4. *Meridion circulare*. 5. *Fragilaria capucina*. 6. *Denticula elegans*. 7. *Odontidium turgidum* (*a* side, and *b* front view). 8. *Diatoma vulgare* (*a* side, and *b* front view). 9. *Astrionella formosa*. 10. *Cyclotella opercula*. 11. *Melosira varians*. 12. *Campylodiseus spiralis*. 13. *Surirella splendida*. 14. *Sphinctoeystis elliptica*. 16. *Synedra* (*a* *splendens*, *b* *capitata*). 17. *Coeconeis pediculus*. 18. *Achnanthes minutissima*. 19. *Achnantheidium microcephalum*. 20. *Cymbella Ehrenbergii*. 21. *Coeconema lanceolatum*, *a* and *b* (*a*, single frustule highly magnified). 22. *Gomphonema acuminatum*. 23. *Pinnularia grandis*. 24. (*a*) *Navi- eula cuspidata*, (*b*) *N. sphærophera*. 25. *Stauroneis acuta*. 26. *Gyrosigma attenuatum*. 27. *Amphora ovalis*. 28. *Tetracyclus lacustris* (*a* side, *b* front view). 29. *Tabellaria floccosa* (*a* side, *b* front view). 30. *Terpsinoc musica* (*a* side, *b* front view). 31. *Mastogloia lanceolata*. 32. *Frustulia saxonica*. 33. *Colletonema vulgare*. 34. *Encyonema paradoxum*.



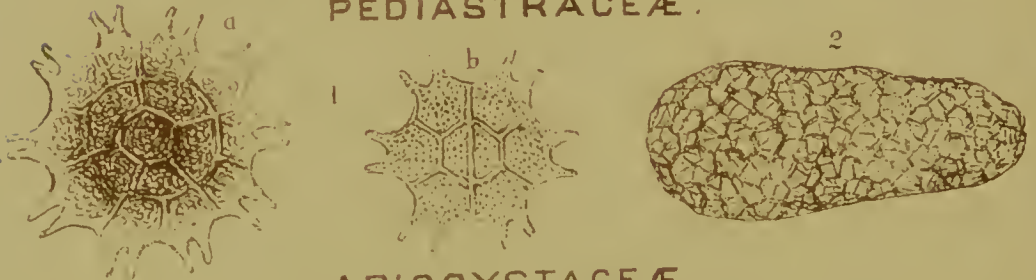




## VOLVOCACEÆ.



## PEDIASTRACEÆ.



## APIOCYSTACEÆ.





## PLATE XI.

### *Volvocaceæ.*

1. *Protoeococcus viridis*, *a*, a single motile cell, and a stationary one undergoing cleavage of the endochrome; *b*, two resulting cells; *c*, cleavage into four, and *d*, into eight new cells, within the primary one. 2. *Tetraspora gelatinosa*. 3. *Gonium pectorale* (*a* seen in face, *b* seen edgewise). 4. *Pandorina morum* (*a* side view, and *b* end view). 5. *Volvococcus globator*.

### *Pediastraceæ* (Provisional).

1. *Pediastrum*. *a*, *Boryanum*. *b*, *granulatum*.

2. *Hydrodictyon utriculatum*.

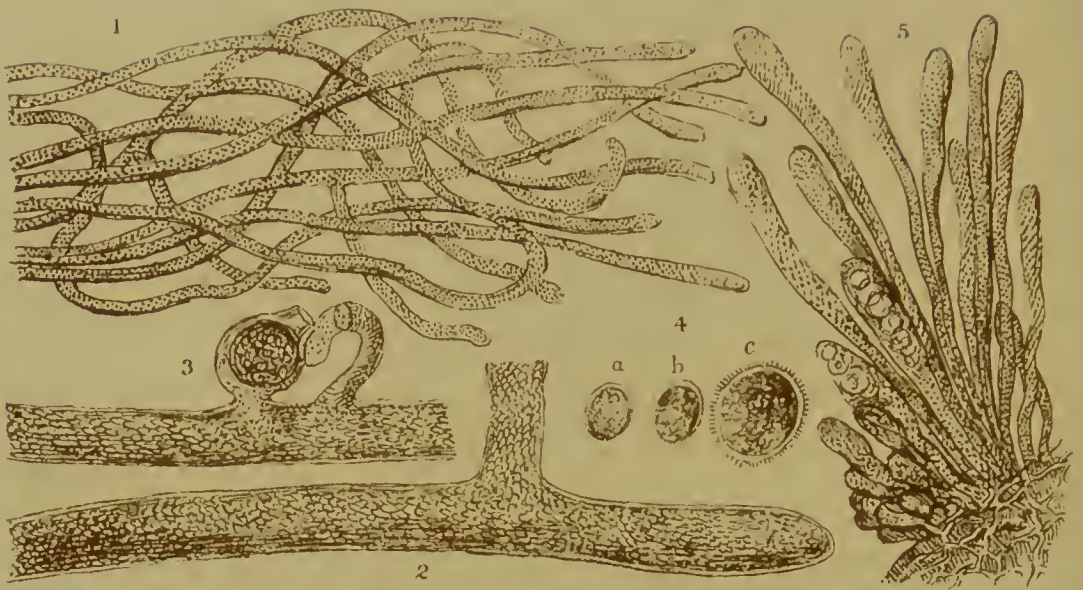
### *Apiocystaceæ* (Provisional).

1. *Apiocystis Brauniana* (*a* young, *b* zoospore). 2. *Hydroeytium acuminatum* (*a*, stages of growth, *b*, shedding zoospores). 3. *Ophioeytium majus*. 4. *Seiadium arbuseula* (*a*, stages of development, *b*, complete form). 5. *Chytridium Olla*, on a filament of *Ædogonium*, one dehiscing and discharging monad-like zoospores. 6. *Pythium entophytum* (*a*, an immature cluster in a cell of *Chlorosphaera*, *b*, one perforating the cell-wall and discharging its contents). 7. *Codiolum gregarium*.

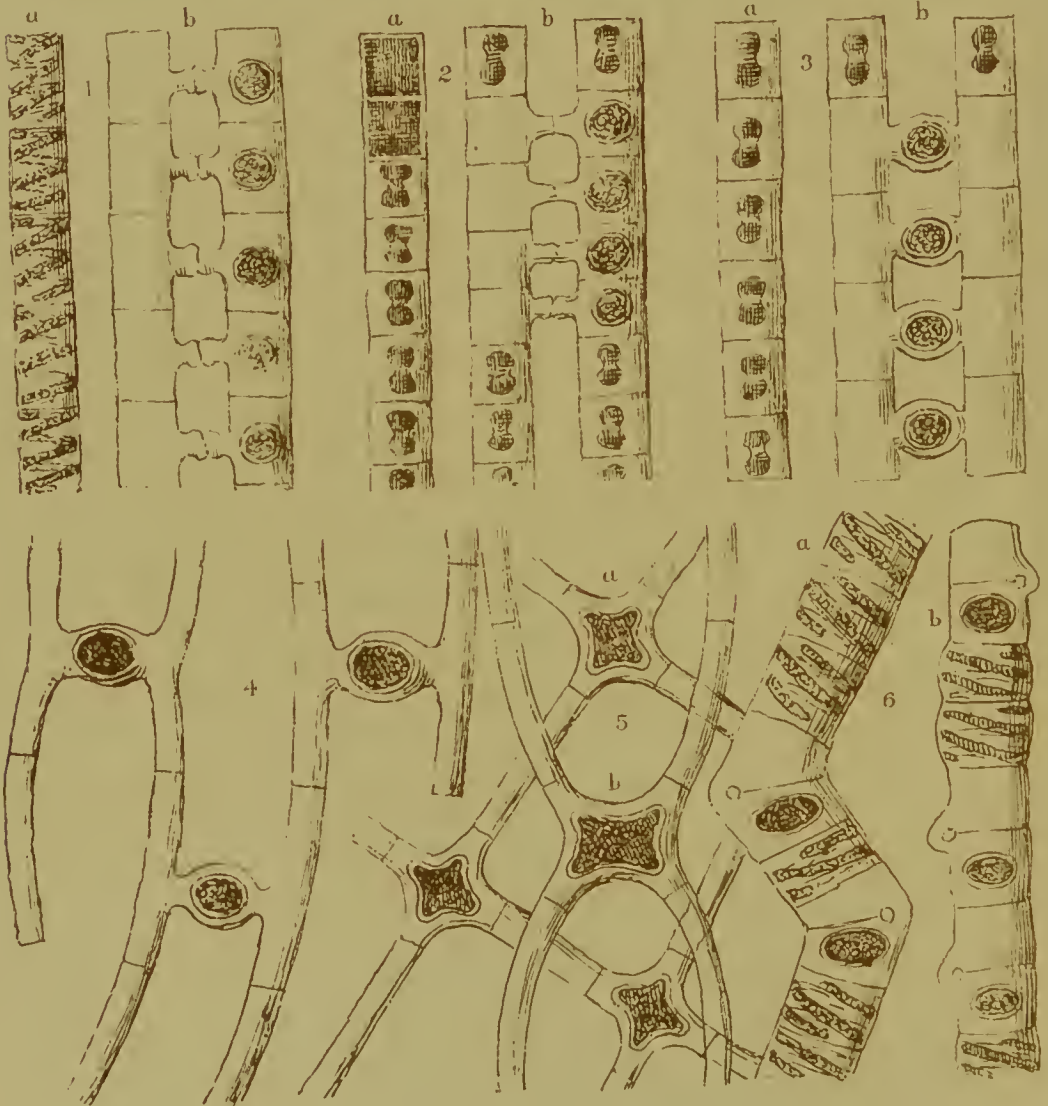




## SIPHONACEÆ.



## ZYGNEACEÆ.



## PLATE XII.

### *Siphonaceæ.*

1. *Vaucheria* Unger. 2. Portion more highly magnified.

3. Sporangium and antheridium. 4. *a* and *b* stages in the development of *c*, the ciliated spore of *Vaucheria*.

5. *Aehlya* prolifera, with its mycelioid rootlets growing upon the dead body of a small fly.

### *Zygnemaceæ.*

1. *Spirogyra*. 2. *Zygnema*. 3. *Zygogonium*.

In all three cases the simple filament is shown at *a*, and the mode of conjugation at *b*.

4. *Mesocarpus*. 5. *Staurocarpus*. 6. *Rhynchosoma*. *a* and *b* in the two latter figures merely indicate different species.







CONFERVACEÆ(a&b) ÆDOGONIACEÆ(c&d) CHÆTOPHORACEÆ(e).





## PLATE XIII.

*Confervaceæ, Edogoniaceæ, and Chætophoraceæ.*

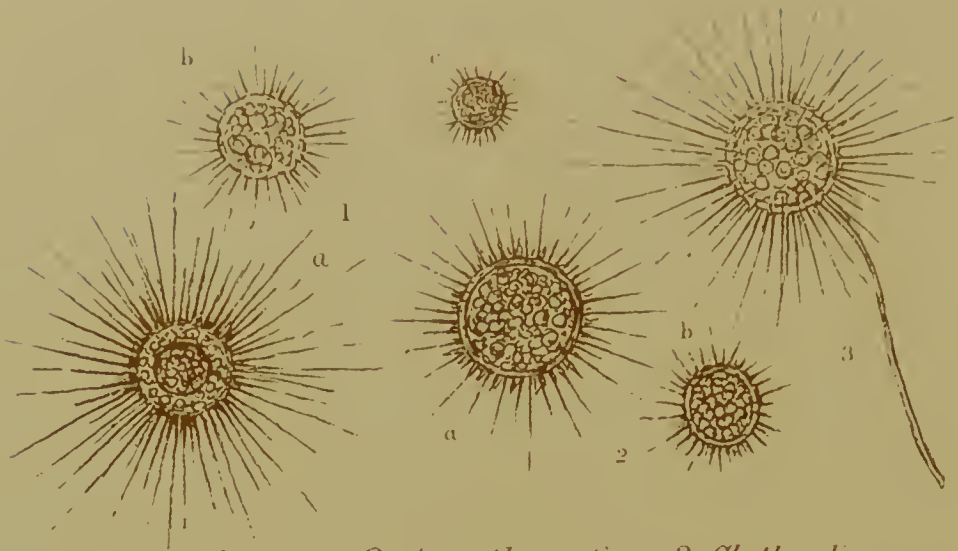
*a.* Conferva floccosa. *b.* Cladophora crispata. *c.* Species of Edogonium. *d.* Bulbochæte setigera. *e.* Chætophora elegans. Amongst the Diatomaceæ introduced in this Plate may be noticed—Long prismatic Synedræ, Tabellaria floccosa, wedge-shaped and stalked Gomphonemæ, with the little bent frustules of Achnanthes minutissima. A spray of pond weed forms the theatre of this microscopic vegetation.





# RHIZOPODA.

## RADIOLARIA.



1. *Actinophrys*.

2. *Acanthocystis*

3. *Clathrulina*.

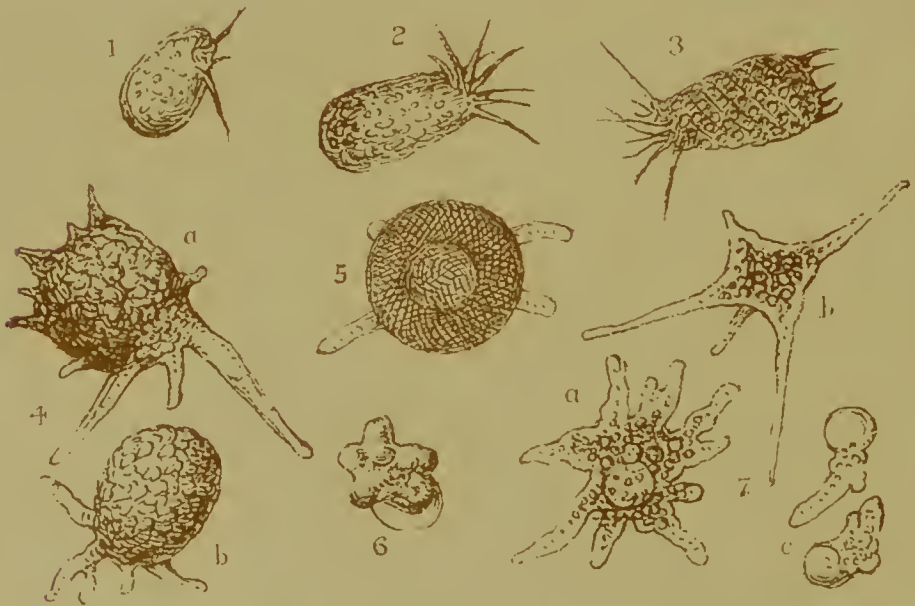
## RETICULARIA



*Pleurophrys*

*Amphitrema*.  
LOBOSA

*Gromia*.



1. *Trinema acinus* 2. *Euglypha tuberculata* 3. *E. alveolata*.

4. *Diffugia*, two forms. 5. *Arcella Vulgaris*, from above. 6. *Cyphodinium*. 7. *Amœba*, several forms.

## PLATE XIV.

### *Rhizopoda.*

#### RADIOLARIA.

1. Actinophrys; (*a*) Eichornii; (*b*) sol.; (*c*) ditto young.
2. Acanthocystis turfacea; (*a*) full grown, (*b*) young.
3. Clathrulina elegans.

#### RETICULARIA.

1. Gromia fluviatilis.
2. Pleurophrys amphitremoides.
3. Amphitrema Wrightianum.

#### LOBOSA.

1. Trincma acinus.
2. Euglypha tuberculata.
3. E. alveolata.
4. Diffugia (*a*) spinosa, (*b*) proteiformis.
5. Arcella vulgaris.
6. Cyphidium aureolum.
7. Amœba, (*a*) ramosa, (*b*) radiosa, (*c*) young of diffuens.





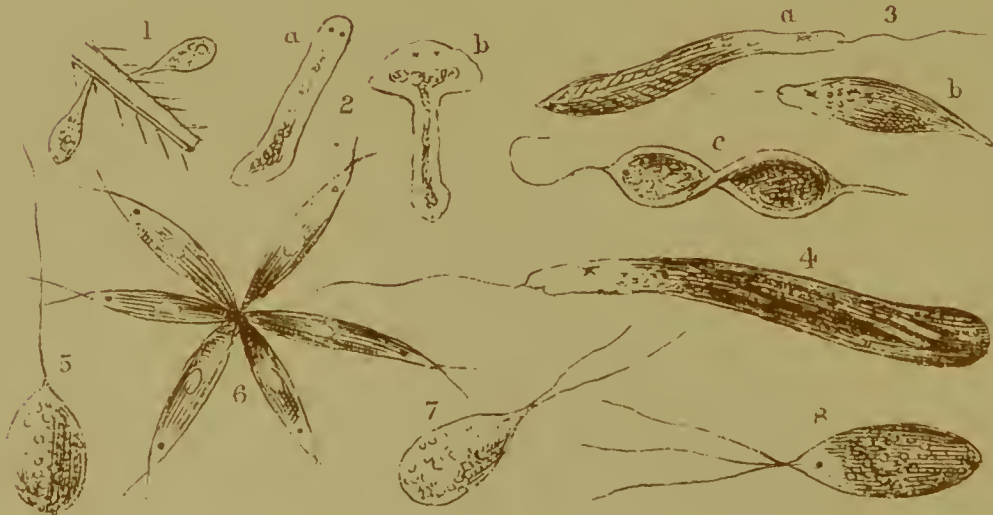
INFUSORIA.  
FLAGELLATA. MONADINA.



DINOBYRYNA.



EUGLENIA.





## PLATE XV.

### *Infusoria.*

#### FLAGELLATA. MONADINA.

1. *Monas* (*a*) *lens*, (*b*) *attenuata*. 2. *Cyclidium* (*a*) *abscissum*, (*b*) *distortum*. 3. *Chilomonas granulosa*. 4. *Amphimonas dispar*. 5. *Cercomonas* (*a*) *longicauda*, (*b*) *lobata*. 6. *Heteromita exigua*. 7. *Trepomonas agilis*. 8. *Hexamita nodulosa*. 9. *Anthophysa Mülleri*. 10. *Uvella glaucoma*.

#### DINOBRYINA.

1. *Epipyxis utriculus*. 2. *Dinobryon sertularia*; (*a*) normal state, (*b*) separate cell more highly magnified.

#### EUGLENIA.

1. *Colacium vesiculosum*. 2. *Distigma*; (*a*) *proteus*, (*b*) *viride*. 3. *Euglena*; (*a*) *spirogyra*, (*b*) *viridis*, (*c*) *longicauda*. 4. *Amblyophis viridis*. 5. *Peranema globulosa*. 6. *Chlorogonium euchlorum*. 7. *Zygoselmis inæqualis*. 8. *Polyselmis viridis*.





FLAGELLATA (*Cont'd*) THECAMONADINA.

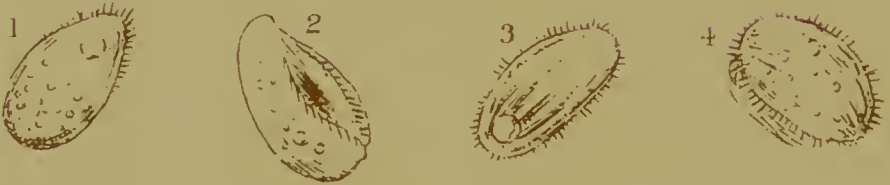


PERIDINÆA.

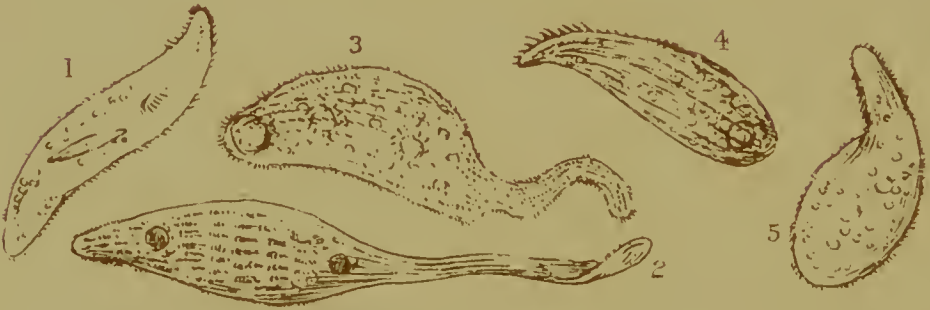


CILIATA.

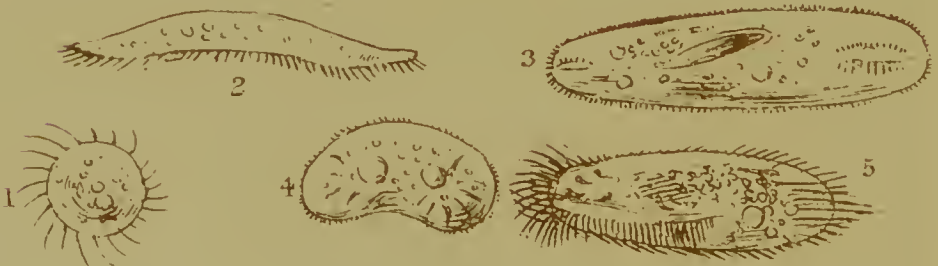
ENCHELIA.



TRICHODINA.



KERONIA.



EUPLOTA.



## PLATE XVI.

### THECAMONADINA.

1. *Trachelomonas volvocina*. 2. *Cryptomonas globulus*.  
3. *Phacus pleuronectes*. 4. *Crumenula texta*. 5. *Anisonema sulcata*.

### PERIDINÆA.

1. *Chætoglæna* sp. 2. *Chætotyphla armata*; (*a*) end, and (*b*) side view. 3. *Glenodinium cinctum*. 4. *Peridinium cinctum*.

### CILIATA. ENCHELIA.

1. *Acomia vitrea*. 2. *Gastrochæta fissa*. 3. *Enchelys nodulosa*. 4. *Alyscum saltans*.

### TRICHODINA.

1. *Pellicida rostrum*. 2. *Dileptus folium*. 3. *Trachelius anas*. 4. *Acincria incurvata*. 5. *Trichoda angulata*.

### KERONIA.

1. *Halteria grandinella*. 2. *Oxytricha gibba*. 3. *Urostyla grandis*. 4. *Kerona polyporum*. 5. *Stylonychia histrio* (*lanceolata*?).

### EUPTOTA.

1. *Himantophorus charon*; (*a*) front, and (*b*) side view. 2. *Euplotes vannus*, (*a*) front, and (*b*) side view.



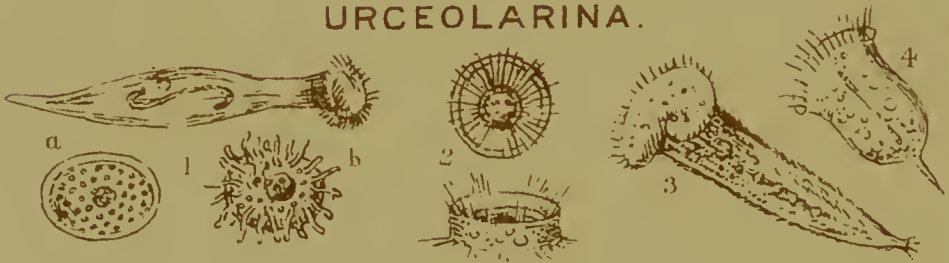




BURSARINA.



URCEOLARINA.



VORTICELLINA.





## PLATE XVII.

### PARAMECIA.

1. *Chilodon eueullulus*.    2. *Nassula elegans*.    3. *Prorodon*  
*teres*.    4. *Glaucoma scintillans*.    5. *Colpoda eucullus*.  
6. *Paramceium aurelia* (three-quarter-view).    7. *Panophrys*  
*crysalis*.    8. *Holophrya ovum*.    9. *Trachelocera olor*.  
10. *Laerymaria proteus*.

### BURSARINA.

1. *Ophryoglena acuminata*.    2. *Bursaria vorticella*.  
3. *Leucophrys* (*a*) *patula*, (*b*) *spathula*, Ehr. (*Spathidium*  
*hyalinum*) Du.    4. *Spirostomium ambiguum*.

### URCEOLARINA.

1. *Ophrydium versatile*, showing an animal in the extended  
state, and (*a*) encysted, (*b*) the supposed *Acineta* form.  
2. *Urecolaria pediculus* (*Trichodina*).    3. *Stentor cœruleus*,  
with internal germs.    *Urocentrum turbo*.

### VORTICELLINA.

1. *Vorticella microstoma*.    2. *Carehesium polypinum*.  
3. *Epistylis crassicollis*.    4. *Opereularia artieula*.    5. *Zoo-*  
*thamnium arbuseula*.





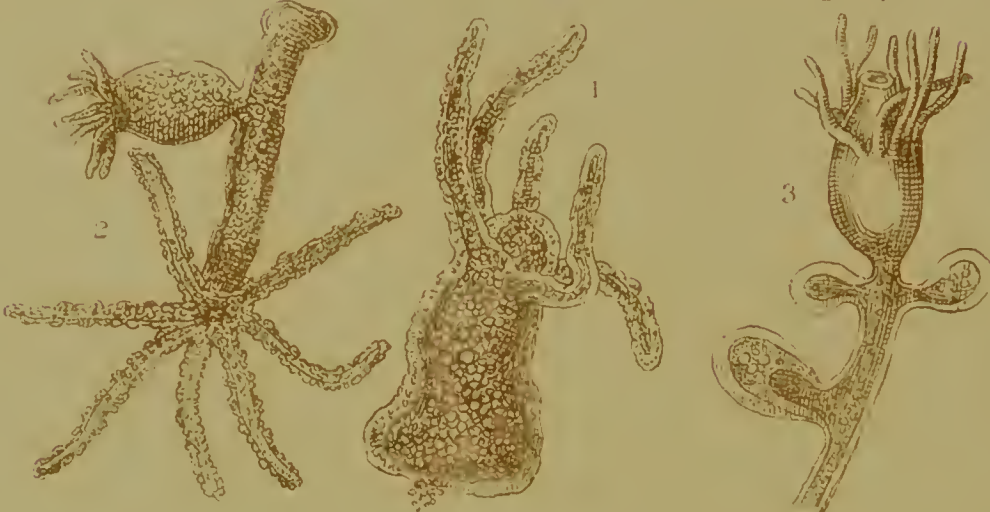
CILIATA (Cont'd) SYMMETRICAL FORMS.



CŒLEENTERATA.

HYDRIDA.

CORYNIDA.



SCOLECIDA.

TURBELLARIA.



## PLATE XVIII.

CILIATA—*continued.*

### *Symmetrical Forms.*

1. *Ichthydium Podura.*    2. *Chætonotus Larus.*    3. *Coleps hirtus.*    4. *Planariola rubra.*

### *Cœlenterata.*

1. *Hydra viridis.*    2. *H. vulgaris.*    3. *Cordylophora lacustris.*

### *Turbellaria.*

1. *Derostomum.*    2. *Prostomum.*    3. *Mesostomum.*  
4. *Planaria.*



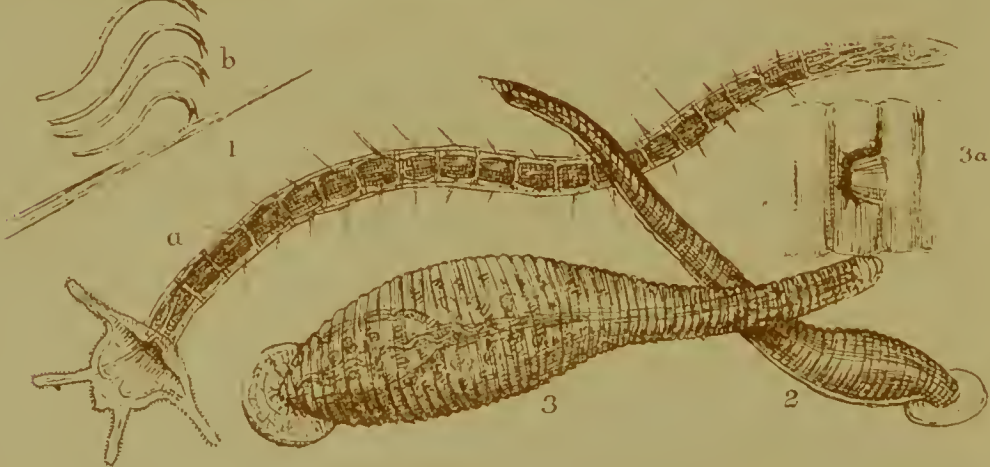




ROTIFERA.



ANARTHROPODA. ANNELIDA.





## PLATE XIX.

### *Nematoda.*

1. *Anguillula* (from bilge water). 2. *A. aceti*.  
3. *A. fluvialis*.

### *Rotifera.*

1. *Cleistes crystallinus*. 2. *Megalotrocha flavicans*.  
3. *Monostyla quadridentata*. 4. *Floscularia ornata*. 5. *Hydatina senta*. 6. *Rotifer vulgaris*. 7. *Brachionus amphiceeros*.

### *Annelida.*

1. *Naid*; (*a*) conformable with the *Proto* of Oken;  
(*b*) setæ, and ventral hooklets. 2. *Nephelis*, sp. 3. *Glossiphonia bioculata*; 3*a*. a dorsal chitinous tooth-like process directed backwards from the eleventh segment, over a little pit in the twelfth.





ENTOMOSTRACA.

OSTRACODA.



COPEPODA.

PHYLLOPODA.



CLADOCERA.



## PLATE XX.

### *Entomostraca.*

#### OSTRACODA.

1. *Cypris tristriata*.    2. *Candona reptans*.    3. *Cythere inopinatus*.

#### COPEPODA.

1. *Cyclops quadricornis*.    2. *Canthocamptus minutus*.  
3. *Diaptomus castor*.

#### PHYLLOPODA.

1. *Branchipus stagnalis*.    2. *Lepidurus*, *Leach* = *Monoculus*  
*Apus* of *Linnaeus*.

#### CLADOCERA.

### *Lynceidæ.*

- |                                  |                                    |
|----------------------------------|------------------------------------|
| 1. <i>Chydorus sphaericus</i> .  | 2. <i>Camptocercus macrourus</i> . |
| 3. <i>Alona quadrangularis</i> . | 4. <i>Pleuroxus trigonellus</i> .  |

### *Daphnidæ.*

- |                              |                                  |
|------------------------------|----------------------------------|
| 5. <i>Daphnia pulex</i> .    | 6. <i>Bosmina longirostris</i> . |
| 7. <i>Sida crystallina</i> . | 8. <i>Daphnella Wingii</i> .     |



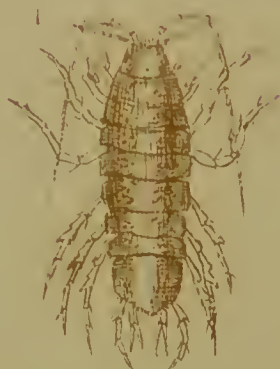


MALACOSTRACA.

1842

ISOPODA.

AMPHIPODA.



ARACHNIDA.

TARDIGRADA.



ACARINA.





## PLATE XXI.

### *Malacostraca.*

- |                   |                       |
|-------------------|-----------------------|
| <i>Isopoda.</i>   | 1. Asellus aquaticus. |
| <i>Amphipoda.</i> | 2. Gammarus pulex.    |

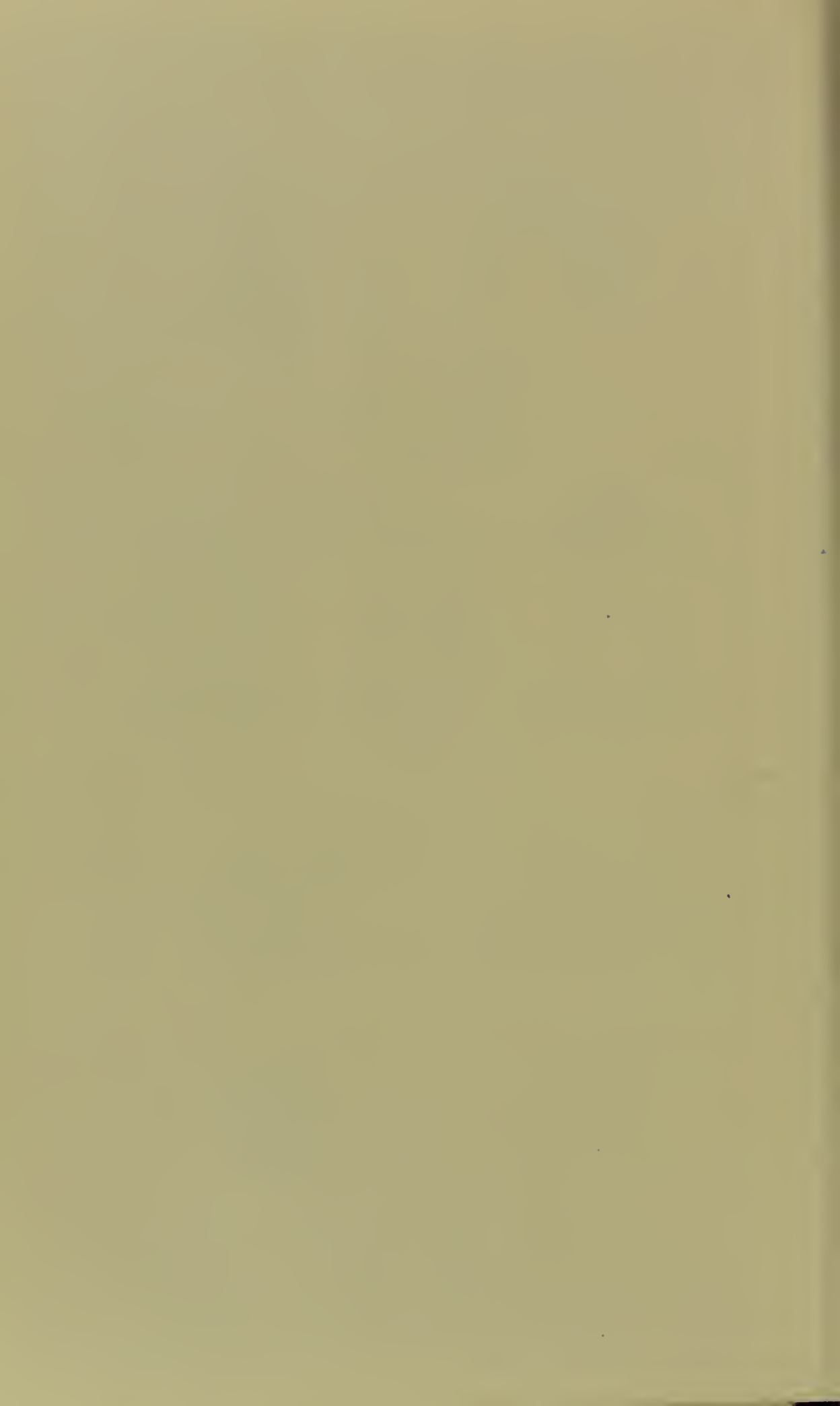
### *Arachnida.*

#### TARDIGRADA.

- |                            |                          |
|----------------------------|--------------------------|
| 1. Emydium testudo.        | 2. Milnesium tardigrada. |
| 3. Macrobiotus Hufelandii. |                          |

#### ACARINA.

1. Hydrachna globula.
2. H. geographica.
3. A more globular form in which, quite exceptionally, six eyes are present.
4. Limnochares holocericus, a crawling water mite.

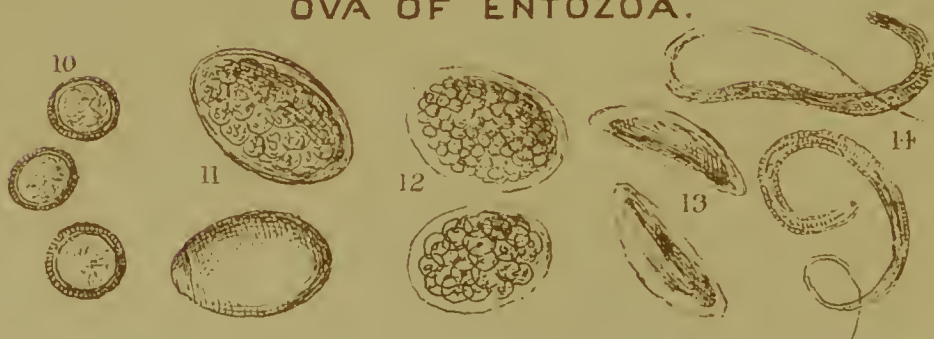




# INSECTA.



## OVA OF ENTOZOA.



## PLATE XXII.

### *Insecta.*

#### COLEOPTERA.

1. Larva of *Acilius sulcatus*.
2. Larva of *Gyrinus natator*.

#### TRICHOPTERA.

3. *Phryanea grandis* in its composite case.
4. The form named *Thelidomus* by Mr. Swainson, who mistook the little built-up case for a genuine shell, and gave it a place among the *Helices* (snails), arranged in accordance with the "quinary system."

The case figured, from the Isle of Pines, S. W. Pacific, was made of granules of ironstone, but in some of the streams of New Caledonia, the retreat of probably the same species, is constructed of little amethysts.

#### HÆMIPTERA.

5. Pupa of *Nepa* (water scorpion).

#### NEUROPTERA.

6. Pupa of *Agrion puella*.
7. Pupa of *Calepteryx virgo*.
8. Pupa of *Ephemera vulgata*.

#### DIPTERA.

9. Larva of the Gnat *Culex pipiens*.

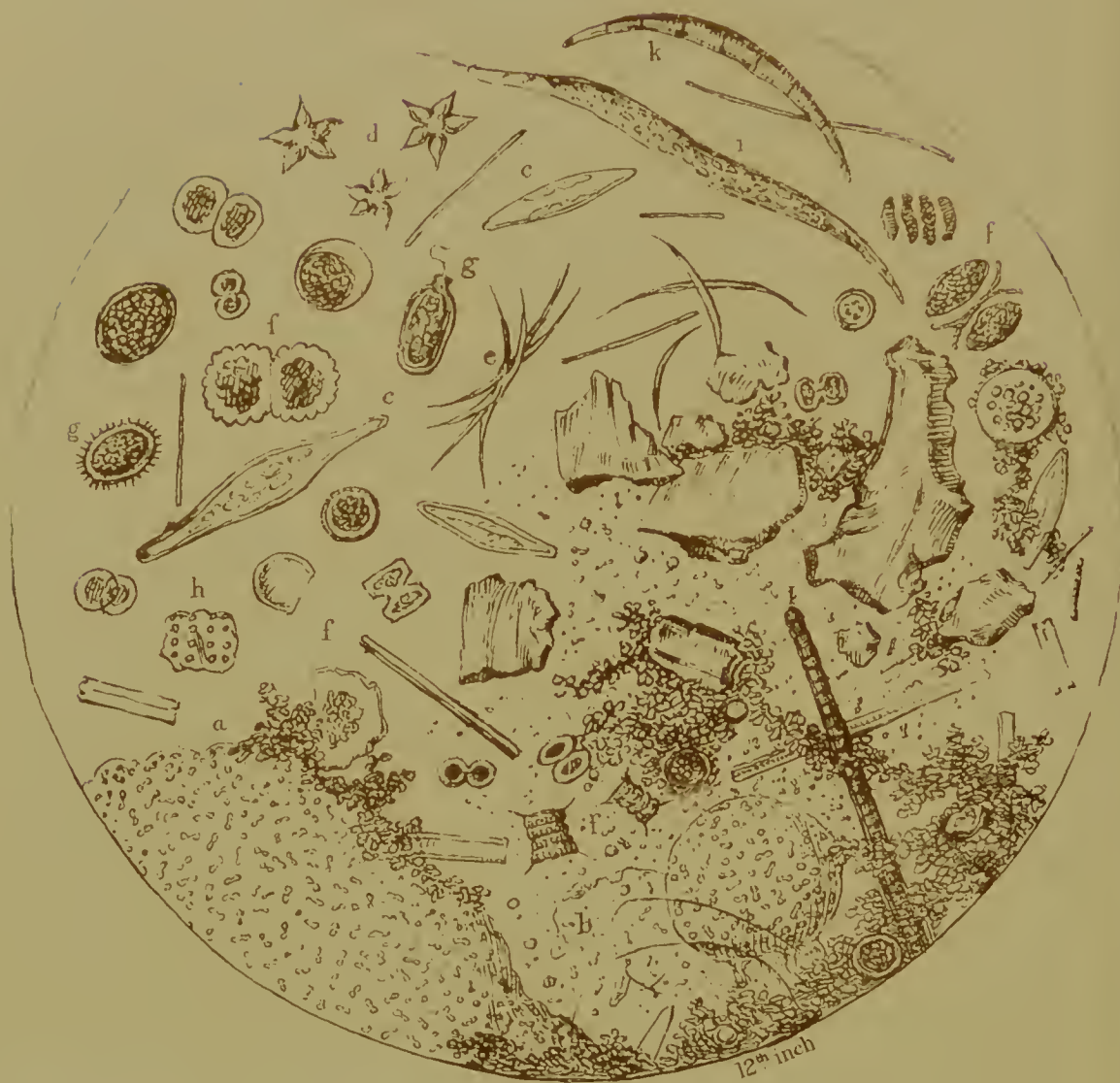
#### OVA OF ENTOMOZOA.

10. Of *Tænia mediocancellata*.
11. Of *Fasciola hepatica*.
12. Of *Ascaris dentata*.
13. Of *Bilharzia hæmatobia*.
14. Young of *Filaria medinensis*.





# WELL-WATER (NETLEY).



a. *Gelatinous fronds  
with Bacteria.*

b. *Monadina.*

c. *Diatomaceæ.*

d. *Star shaped cells*

e. *Ankistrodesmus.*

f. *Desmidiaceæ.*

g. *Thecomonadina.*

h. *Palmella, (minute.)*

i. *Englena viridis.*

k. *Spore of Septoria, (fungus).*

l. *Oscillatoria.*



## PLATE XXIII.

### *Well-Water (Netley).*

The suspended matters represented in this Plate were obtained by setting aside a tall glass litre measure full of the water, with a disc of glass attached to a long wire at the bottom. During the first twelve hours a deposit of grosser particles was formed, with a delicate coating here and there of the gelatinous matter and bacteroids shown at *a*. In twelve hours more this coating had become more consistent, and at the end of forty-eight hours was so firmly adherent as to require some force to remove it, with the mineral particles, resting-spores of algæ, and organic débris of different kinds embedded in it.

In the little bays and creeks of this gelatinous substance the loosened and detached Bacteria were in active motion, and interspersed with Monads (*b*) of minute size.

Navicula, Synedra, and other Diatoms (*c*), were free in the field, or often projecting from the amorphous débris. The little green star-like bodies (*d*) probably allied to the Tetrapedia, have also been noticed in other specimens obtained from a deep source, and are evidently identical with those figured in Plate 4, illustrating the Reports made to the Directors of the London (Watford) Spring-Water Company by Drs. Lankester and Redfern.

The remaining objects are sufficiently explained in the references attached to the Plate.





## BOG-WATER.



a . *Particle of bog moss.*

b . *Oscillatoria.*

c . *Peridium.*

d . *Cosmarium.*

e . *Closterium.*

f . *Tettnemorus.*

g . *Navicula.*

h . *Surirella.*

i . *Pinnularia.*

k . *Chaetoglena.*

l . *Actinophrys.*

m . *Diffugia.*

n . *Arcella.*

o . *Brown Vegetable cells.*

## PLATE XXIV.

### *Bog Water.*

The specimen of water here represented was taken from the swampy ground near Miller's Pond, Sholing, Southampton. It was very rich in Rhizopoda, Infusoria, Oscillatorians, and Desmids large and small, and the beautiful *Pinnularia grandis*, which is so plentiful in all the surrounding district, but chiefly in stagnant and impure water.



A GUIDE  
TO THE  
MICROSCOPICAL EXAMINATION  
OF  
DRINKING WATER.

---

INTRODUCTION.

MODE OF COLLECTING SEDIMENTS AND PLACING THEM UNDER  
THE MICROSCOPE—MICROSCOPICAL POWERS—IMMERSION-  
LENSES.

WHEN water is very turbid, from an obviously impure source, it is easy enough to obtain a sufficient amount of sedimentary matter for microscopical examination, and a just estimate of the unfitness of such water for drinking purposes may be thus readily formed. But it more frequently happens that the deposit, even after long standing, is but slight, and when this is the case, we must have recourse to special means by which the whole, or a large amount of the matters in suspension may be concentrated, or collected together within a small compass. In the first place a tall glass vessel will be required, a litre or half-litre measure glass will answer very well, and when filled up to the mark, a circular disc of glass, resting upon a horizontal loop at the end of a long wire, should be let down to the bottom of the vessel, and the whole arrangement, lightly covered, set aside for twenty-four or forty-eight hours, as the case may be.



At the end of the specified time, the water may be siphoned off with a piece of india-rubber tubing, only leaving a thin stratum over the glass disc. This should now be carefully raised, and laid upon a piece of blotting-paper, so as to dry its under surface, when it may be at once transferred to the microscope, with a large piece of thin covering glass so placed upon it as to exclude all air-bubbles.

Another good plan is to siphon off the water until only a sufficient quantity remains to permit the sediment to be shaken up with it, and poured into a tall conical glass, from which, after standing again for a short time, portions may be taken up by means of a pipette, and placed on a slide for examination. A thin glass cover is always required, not only to equalize the refraction, but to confine the fluid and prevent evaporation, by which an obstructive dew would naturally form upon the object glass. In the manner just mentioned the specimen of well-water sediment represented in Plate XXIII. was prepared. The gelatinous matter, developed by the bacteria-like cells at the lower part of the figure, (*a*) was only loosely adherent at the close of the first day; but, subsequently to this, or during the next forty-eight hours, it formed a delicate but perfect incrustation at the bottom of vessel. Many of the little bodies, detached from the gelatinous frond, were seen in active motion in the immediate vicinity. More definite fronds, with still more minute bacteriform bodies growing upon a decomposing spray of pond weed, are shown in Plate VII. as seen with a sixteenth of an inch immersion-lens. The first of these forms, at least, would seem to exhibit an alliance with the *Palmellaceæ*, while others, which are very readily confounded with them, show a marked affinity with the *Oscillatorians* (see further remarks on this subject under the head of *Bacteriaceæ*).

It will be apparent, from the foregoing observations, that the sediments of comparatively clear water require the very highest



microscopical powers for their investigation, and the employment of immersion-lenses if available. Filamentous algæ, even narrower than true bacteria, may be thus frequently brought into view, as well as the delicate flagellæ or locomotive organs of monads, whose bodies alone would be scarcely visible with lower powers. It is also important to mention that, by these means, even in the absence of ordinary amœbæ, particles of protoplasm of bacterium size, exhibiting amœbiform movements, are often discernible. Lastly, very finely-divided mineral matter in suspension, giving rise to milkiness or haze, can only be studied with immersion-lenses, though certain cases may occur in which no objective cause of these conditions can be detected microscopically.

Mineral matters of various hues in the soil, through or over which water percolates or flows, are the more usual causes of discoloration and turbidity. Peroxide of iron, in particular, may be mentioned as the source of the brown cloudy appearance of water from the blue clay, as also, frequently, of the brown colour of pools in bog-lands, though this is more likely to arise from organic matter in a state of decay. In the coarser sediment, under such circumstances, the microscopic forms of animal and vegetable life are likely to be abundant (viz., *Rotifera* and *Infusoria*, *Oscillatoriaceæ* and *Desmidiaceæ*). In ferruginous bog-water also the twin-spiral filaments of *Didymohelix*, invested with a yellowish-brown gelatinous matter, and *Leptothrix ochrea*, a rather ill-defined mycelioid structure, may add to the general effect. By reflected light, moreover, the fine amber tint of the *Diatomaceæ*, floating or resting, is quite brown. Some of the heterogeneous materials usually occurring in bog-water are represented in Plate XXIV.

## SECTION I.

### MINERAL MATTERS. (PLATE I.)

MINERAL matters in suspension in water often give a turbidity of a colour and character indicative of their nature. When the particles are large, they will descend more rapidly; but when very subtle or minutely divided, the suspension being more complete, a longer time will be required for their subsidence. Looking down through a considerable depth of the water, with the glass vessel containing it resting on a white ground, will afford some preparatory information, when compared with a corresponding stratum of distilled water in a second vessel observed in a similar way. Haziness, or peculiarity of colour, may be thus detected, which would be quite inappreciable in a thin layer. With a long glass tube a stratum of two or more feet might be obtained, and the method is also valuable in observing the effect of reagents or tests in water. In the light of preparatory information, it may be stated, moreover, that sandy particles and clay in suspension give a yellowish-white turbidity; and on boiling the water, as Professor Parkes observes, "sand, chalk, and heavy particles of the kind will be deposited," and if it be a chalk water the calcium carbonate will carry down suspended sewage or vegetable matter, effecting a change of colour. Under such circumstances the sense of smell may afford confirmatory evidence.

Silicious particles, as of flint or sand, are usually angular; and though often much rounded by rolling and attrition, vitreous fracture will be observable in many of them, as shown

in Plate XXIII. It should be mentioned here, that a little source of fallacy may be occasioned by the very frequent detachment of minute scales or chips from the margins of the covering glass, or the extremity of the pipette, when not properly ground, or even from the glass stoppers of bottles in which specimens are kept. On carefully inspecting the more minute particles of silicious matter, which are so easily diffused and suspended in water, their thin or scale-like character will be apparent. Particles of chalk, clay, and marl, on the other hand, are usually more rounded, but the former will be at once recognised by their solubility in acids. The crystalline forms of numerous substances are frequently visible in the smallest molecules. Indeed, the study of the inorganic matters in the sediments of fresh water, is a branch of Microscopical Mineralogy which is of growing interest and importance to the water analyst. It would of course include goniometry and spectrum analysis, and will no doubt receive the attention it deserves in time to come.

## SECTION II.

### DEAD, OR DECAYING ORGANIC MATTER.

ANY of the forms described in the succeeding Section, as living plants and animals, may be found in the sediment of drinking water, either whole or fragmentary, in a dead and more or less decayed state. Their recognition will, in many cases, be difficult in consequence of the accumulation of débris of different kinds about them, as well as their own altered condition. But, when the more unyielding structures remain intact, a little practice, with the help of figures, will enable the observer to determine them with sufficient accuracy for all practical purposes.

#### A. *Dead Vegetable Matter.* (PLATES II. & III.)

When the higher plants die down, those of a more humble kind seem to flourish with greater vigour, so that however shapeless the decaying masses may be, minute *Oscillatorians*, *Bacteria*, and their allies will usually be found in their vicinity. The breaking down of vegetable cells is of course attended with the discharge of the contained cell-sap, endochrome, &c.; and these will soon assume an amorphous, or irregular granular appearance, in which the original green colour is here and there very evident. Its further change, however, is usually into an olivaceous or yellowish-brown tint. In some instances the albuminous inner coat of the vegetable cells, known as the primordial utricle, is seen much contracted within the cellulose coat, passing into an indigo purple tint in a more advanced

stage of decay. With a little care, the collapsed and crumpled cell walls may be recognised easily. But, very characteristic of decaying vegetable matter, if it appertain to vascular plants, is the occurrence of spiral vessels, or even the spiral fibres drawn out of the cells; annular ducts, dotted and pitted tissue, and hairs, which, from their comparative indestructibility, are sometimes very beautifully dissected out, as it were, by maceration. These at once afford a clue to the nature of the amorphous matter in connexion with which they are found.

The little scales of "bog moss" (*Sphagnum*), with their porous or fenestrated cells, the discs and roots of duckweed (*Lemna*), and sprays of "pond weed" (*Potamogeton*), and the "stoneworts" (*Chara* and *Nitella*), may also be met with, more or less altered in colour, or otherwise.

Amongst the vegetable products (Plate III.) not properly belonging to the fresh water, but indicating contamination from house refuse, may be mentioned the fibres of fabrics, such as linen (1), the hemp of twine (2), cotton (3), and the discoidal tissue of ordinary deal or pine (4), a structure, it may be remarked, which is characteristic of the *Coniferæ* as a whole.

#### B. *Dead Animal Matter.* (PLATES IV. & V.)

Decaying animal, as well as vegetable matter, may consist of materials proper to the fresh water or foreign to it. To the first class belong, in particular, the dead bodies of the *Entomostreca* (water fleas, &c.), and the numerous forms of segmented or *Annulose* animals, including the water-bears and mites, the larvæ of aquatic insects, and the *Annelida*. Indeed the latter are often only to be recognised by their indestructible setæ and ventral hooks, which may ultimately become quite isolated in the field. Animal products, not proper to the fresh water, may embrace the bodies or exuviae of terrestrial insects, house-



flies and others, often overgrown with *Achlya*, a parasitic siphonaceous plant (Plate XII. 5), and matters such as are represented in Plate V., to which the following references will apply:—

1. Fibres of silk. 2. Wool. 3. Human hair. 4. Hair of rabbit—*a*, the shaft, and *b*, the extremity. 5. Epithelium from the mouth. 6. Ditto from the cutaneous surface. 7. Striped muscular fibre. 8. A feather. 9. Portions of ditto, more highly magnified. 10. Scales of Lepidoptera.

The scales of moths and butterflies are usually flat, with fine longitudinal fluting and a serrated extremity. Hairs properly so called have commonly a soft central axis of cells, often absorbed so as to form a medullary cavity. Wool, on the other hand, is much smaller and more compact in the centre, while the superficial imbrication of the component cells is more distinctly marked. Human epithelial scales are broad and flat, with an oval highly refringent nucleus and minute scattered points in the surrounding space. They resist maceration for a considerable time, and thus frequently percolate with other impurities from latrines into neighbouring wells.

It may not be out of place here to call the attention of the observer to the possible presence of the eggs of Entozoa in the water under examination. All spherical and ovoid bodies with albuminous-looking and segmented contents should be looked upon with suspicion, until their real nature has been determined; accurate measurements of them should be taken, and drawings if possible. (See Plate XXII., Figs. 10—14.)

## SECTION III.

### LIVING FORMS.

THE simplest grades of plants and animals or the Protophyta and Protozoa possess so many characters in common, that it is by no means easy to determine the true nature or position of numerous minute organisms, which constantly present themselves in the field of the microscope. The most reliable means of distinguishing them is founded upon physiological grounds, and more especially their mode of nutrition. For it is quite admitted that no structural particulars can be named, in the abstract, as characterizing the one more than the other. Of course, where the life history of any form has been satisfactorily traced out the determination must be certain; as for example, when a Zoospore, furnished with motile organs or flagella, is found not only to originate in a bonâ-fide plant, but ultimately to grow into one itself. Of such organisms, unquestionably, Dujardin's *Flagellata*, or first Order of Infusoria (B, I. 2) (*a*) mainly, if not altogether, consists. Others of a similar description usually associated in groups in a gelatinous frond, occur in the *Volvocaceæ* (A, II. 7). To the casual observer, the equivocal movements executed by the forms of doubtful position are more striking than their intimate structure, while the other parts of their history are quite out of the question. Indeed, in many cases, a claim to belong to the animal kingdom has been raised alone upon the exhibition of animal-like movements. The liability to error is therefore all on one side, and as far as we know not a single genuine protozoon has ever been classed by the botanist in his domain,

while our greatest difficulty at the present time is to eliminate the protophyta from the realm of zoology.

It will be scarcely doubted that the numerous species of *Diffugia*, *Arcella*, and *Euglypha* are veritable animals; but what are we to say of the equally numerous *Amæbæ*, now that we are acquainted with the truly vegetable *Amæboids* of *Volvox*, and of the roots of mosses, through the researches of Dr. Hicks, F.R.S. The pliant *Vibrio* and the rigid *Diatom* exhibit the phenomenon of spontaneous movement, connected no doubt with the play of the same, or similar nutritive processes, developing dialytic currents, which are on this account quite invisible, while they operate as a moving cause on moveable bodies. In this way the rigid diatom moves without change of form, and shall we say by the same law the extensile plasma of the passive amœboid is drawn out into pseudopodia, with the semblance of active, and even of voluntary motion?

The following kinds of movement may be noticed and compared in the two kingdoms:—

		<i>Protophyta.</i>	<i>Protozoa.</i>
Movement.	{ Without special organs .....	{ Without vibration    SPIRILLUM .....	GREGARINA.
		{ With vibration ...    VIBRIO .....	—
	{ With special organs .....	{ By pseudopodia ...    Amœboids of VOLVOX..	AMÆBA.
		{ By cilia .....	Spores of VAUCHERIA..    PARAMECIUM.
		{ By flagella .....	EUGLENA.....    PERIDINIUM.

Above the lowest grades of plants and animals, or such as are notified in the preceding table, no difficulty can arise in assigning to every form its true position.



A. *Living Plants.*

COMPRISING THE MORE USUAL AQUATIC ALGÆ OCCURRING IN  
THE EXAMINATION OF DRINKING WATER.

Though our knowledge of the fresh-water Algæ has become greatly extended of late years, we are still only in possession of fragmentary particulars in relation to many of the more humble forms; and until the whole life-history of each has been satisfactorily traced out, it would be quite impossible to group them so as to be altogether free from objection. The classification here adopted cannot, therefore, purport to be perfect, but it is hoped that it may serve as a guide to the leading characters of the vegetable products usually presented to the observer in the microscopical examination of drinking water.

*Systematic Arrangement.*

The numerous types of fresh-water Algæ would appear to admit of natural distribution into three groups or sections, distinguished as follows:—

*Group I.* Plants which, although for the most part exhibiting spontaneous motion in themselves, have yet no special provision for movement in their reproductive elements.

Families included in this group, viz.:—

- |                                                      |                        |
|------------------------------------------------------|------------------------|
| 1. <i>Bacteriaceæ.</i> ( <i>Bacteria</i> , of Cohn.) | 4. <i>Palmellaceæ.</i> |
| 2. <i>Oscillatoriaceæ.</i>                           | 5. <i>Desmidiaceæ.</i> |
| 3. <i>Nostochaceæ.</i>                               | 6. <i>Diatomaceæ.</i>  |

*Group II.* Plants in which motile (*i.e.*, ciliated or flagellate) cells play the most conspicuous part, either separately, simply aggregated, or organically united in a definite manner in a gelatinous frond.

This group includes a single family, viz. :—

7. *Volvocaceæ*.

Group III. Plants in which all movement is confined to the reproductive elements, comprising the remaining families, viz. :—

- |                           |                                |
|---------------------------|--------------------------------|
| 8. <i>Pediastraceæ</i> .  | 13. <i>Confervaceæ</i> .       |
| 9. <i>Ulvaceæ</i> .       | 14. <i>Ædogoniaceæ</i> .       |
| 10. <i>Apiocystaceæ</i> . | 15. <i>Chætophoraceæ</i> .     |
| 11. <i>Siphonaceæ</i> .   | 16. <i>Batrachospermaceæ</i> . |
| 12. <i>Zygnemaceæ</i> .   | 17. <i>Characeæ</i> .          |

---

*Definition of the foregoing Families, and of the more important Genera appertaining to them.*

GROUP I.

FAMILY I.—*Bacteriaceæ*. (PLATES VI. & VII.)

Under the head of *Bacteria*, Cohn has included all the very minute spherical, elongated, rod-like, straight, and spiral filamentous plants endowed with more or less active spontaneous motion; and now found to be associated with putrefaction and other conditions of hygienic importance.

The annexed table is in accordance with Dr. Cohn's own classification, which he admits must be only provisional, until something more definite is known of the nature and affinities of these interesting organisms. Though the species are not separately described, it was considered advisable to retain them in the table to facilitate further reference, should it be found necessary.

*Bacteria* (Cohn).

## GENUS AND SPECIES.

A. SPHÆROBACTERIA.....		<i>Micrococcus.</i>
(Minute jostling spherules.)	Zymogenous. (Ferment producing.)	(c) crepusculum (Ehr.) candidus (Cohn)
	"	(d) ureæ (Cohn) The ferment of ammonia- cal putrescence.
	Chromogenous. (Colour producing.)	(a) prodigiosus (Ehr.) The blood stain in bread.
	"	luteus (Schrøter)
	"	aurantiacus (Sch.)
	"	chlorinus (Sch.)
	"	cyaneus (Sch.)
	"	violaceus (Sch.)
	Pathogenous. (Disease producing.)	(b) vaccinæ (Cohn) diphthericus (Dartel) septicus (Klebs) bombycis (Béchamp)
B. MICROBACTERIA.....		<i>Bacterium.</i>
(Minute and short rods.)		(f, g, h, k) termo (Ehr.) Producing putrefactive fermentation.
	Chromogenous.	(i, l) lineola (Ehr.) In brooks, &c. xanthium (Sch.) syncyanum (Sch.) æruginosum (Sch.)
C. DESMOBACTERIA.....		<i>Bacillus.</i>
(Straight, flexible or rapidly undu- lating filaments.)		(n) subtilis (Ehr.) Producing Butyric fer- mentation.
		(m) ulna (Kohn) Similar to the former. anthracis (Cohn) In the blood, in malig- nant pustule.
D. SPIROBACTERIA.....		<i>Vibrio.</i>
(Spiral filaments, rigid, or flexi- ble.)		(o) rugula (Ehr.) (p) serpens (Ehr.)
		<i>Spirillum.</i>
		(q) tenue (Ehr.) (r) undula (Cohn) (s) votutans (Ehr.)
		<i>Spirochæta.</i>
		(t) plicatilis (Ehr.)

While there is little doubt of the intimate relationship existing between the larger forms of the preceding table and the Oseillatorians, *Bacterium termo* and its immediate allies are involved in much obscurity as to their real nature and botanical affinities, seeing that their supposed position in the animal kingdom is now no longer tenable. The slightly dumb-bell shape of the true putrefactive *Bacterium* manifests a very significant correspondence with the form represented in Plate XXIII., developed in the sediment of well-water, and with many others such as that shown in Plate VII., occurring amongst decomposing Algæ.

All analogy would go to indicate that the Zooglæa form of *Bacterium termo* may be regarded as the primary or normal state of this organism, the surrounding gelatinous matter being simply the representative of that which forms the indefinite frond of *Microhaloa* or *Palmella* for example.

Further, when the matrix breaks down, and the separate little *Bacteria* detach themselves from it, they often commence those active movements which are in some intimate way connected with their nutrition. Even many *Diatomaceæ* which are normally fixed to, or included in a gelatinous frond are motionless until they have become free from it, when the movements they exhibit are known to bear a certain relation to the shape of the frustule, being rectilinear when the latter is narrow, but more irregular when it is of a different form. The subsequent history of *Bacteria* has been variously represented by authors, but our space will not admit of further enlargement upon this subject.

The carbon of the higher aquatic plants is derived from the carbonic acid present in the water, or liberated by the decomposition of carbonates, while that of the molecular and more minute filamentous Algæ (*Micrococcus*, *Bacterium*, &c.) is usually

derived from the vegetable acids that may be in combination with a base, as for example, the  $\overline{T}$  of Tartrate of Ammonia.

Dr. Cohn's researches go to show that, not only will *Bacteria* flourish in solutions of the salt just mentioned, or in the absence of organic matter, but that even in this case the genuine putrefactive odour is evolved. This important fact would therefore link the presence of *Bacteria* with putrefaction as a process quite distinct from simple decay, with which fungous-life is more particularly associated.

FAMILY II.—*Oscillatoriaceæ*. (PLATE VIII.)

These very simple plants consist of tubular filaments, with or without a gelatinous investment, and having faint or rich bluish-green or purple coloured contents, or endochrome, in which, as the filaments elongate, a transverse segmentation takes place, giving rise to the deceptive appearance of cells in single series. The filaments may be quite free, or disposed in bundles or strata. In the free state, their peculiar animal-like movements render them objects of interest to the microscopist. Branching, in the true sense of the term, is quite foreign to these plants, which multiply by transverse fission; but of their sexual reproduction nothing is precisely known. Excluding the *Bacteria* of Cohn, they are divided into several sub-families, which are easily distinguished in the following manner:—

		Sub-families.	Genera.
Frond or filament	Cylindrical.	{ Exhibiting more or less active movements .....	<i>Oscillatoriaceæ</i> ... (1.) OSCILLATORIA.
		{ Like <i>Oscillatoria</i> , but in tufts or strata.	<i>Lyngbyaceæ</i> ..... (3.) LYNGBYA.
		{ Having a proper gelatinous investment .....	<i>Scytonemaceæ</i> ... (4.) SCYTONEMA.
		.....	(2.) MICROCOLEUS.
	Tapering, with a large basal cell.....		<i>Rivulariaceæ</i> ... (5.) RIVULARIA.



It is highly probable that many of the supposed members of *Oscillatoriaceæ* are truly referable to the succeeding family (*Nostochaceæ*).

On carefully inspecting a fair specimen of water rich in Algæ of different kinds, it will usually be easy to trace examples of *Oscillatorieæ* ranging from the proportions of ordinary *Confervæ* to the diameter of *Bacterium termo*. The same phenomena of endochrome-cleavage and spontaneous movement will be seen to occur in all cases, in a more or less marked degree; and indeed any differences distinguishable in the smaller, as compared with the larger forms, can only be said to be of a relative kind, and apparently in no way contraindicate a prevailing unity of type. Frequently also the smallest moving points or molecules observable in the field, instead of being referable to the genus *Micrococcus*, are but segments of the more minute filamentary species or varieties, as the case may be; for, even if their cylindrical form is not demonstrable to the eye, their peculiar refractive properties will enable us to link them with the less equivocal fragments always to be found in the same vicinity.

In the punctiform, fragmentary, or filamentous plants of smaller size than the admitted Oscillatorians, it is impossible to distinguish a primordial utricle and a cellulose coat, and of course also difficult to determine the precise nature of the segmentation. In the *Oscillatorieæ*, however, the endochrome suffers cleavage, while the primordial utricle and the cellulose tube take no part in the process, being only capable of simple growth and extension. In the *Confervaceæ* and other filamentous Algæ, on the contrary, both the primordial utricle and the endochrome are engaged in the segmentation of the filament, within the cellulose coat, to which, nevertheless, the transverse septa and a new internal layer are added.

In a very interesting paper published in the *Quarterly Journal*

of *Microscopical Science*, vol. i. 1861, Dr. B. Hieks, F.R.S., has touched a most important subject in what he has termed the Diamorphosis of *Lyngbya muralis*. This plant, though confounded by some with the genuine *Confervæ*, is now generally admitted to be an ally of the Oscillatorians, and as such at least one of its modes of reproduction, or transitional phases, presents a suggestive bearing upon all the members of this family, and thereby, it may be fairly presumed, upon *Bacteriaceæ* in general. We thus perceive how slender are the grounds upon which we can assume almost any palmellaceous plant to be a distinct entity, and in this remark may be included some forms reputedly belonging to the *Ulvaceæ*. Let us suppose for a moment that the minute spirilla and even *Bacterium termo* itself are in the category of the filamentous algæ, then how small must be their reproductive gonidia!

From actual observation of the spirillum common in bilgewater, I can safely say that the moving particles in which it originates, however small they may have been in the first instance, are not only very minute, but quite shapeless. If these reproductive particles are visibly so small in relation to the diameter of a normal filament of *Lyngbya muralis*, how minute must they be in the case of *Bacterium termo*! They might readily escape the keenest scrutiny of the advocates of equivocal generation.

### FAMILY III.—*Nostochaceæ*. (PLATE VIII.)

Plants consisting of microscopie moniliform filaments of cells in series, usually coiled, curved, or entangled in a gelatinous matrix constituting the frond, which may be round or foliaceous, linear, or formless. They are found on damp

ground, or in water, floating on the top, or at the bottom, attached to stones in rivulets and streams, or in brackish ditches.

The characters of the frond sufficiently distinguish the three more important genera, thus—

Frond	{	<i>Expanded</i> ...	Globular or irregular; filaments numerous .	(1.) NOSTOC.
		<i>Elongated</i> ...	Curved, linear, or spiral; filaments single .	MONORMIA.
		<i>Formless</i> ...	Often a floating film; filaments numerous .	(2.) TRICHORMUS.

Besides simple multiplication by fission (which is sometimes longitudinal as well as transverse), the *Nostochaceæ* afford indications of the existence of a true reproductive process, in the presence of certain vesicular cells (supposed to be spermatic?) amongst the ordinary ones; which latter are, moreover, here and there further developed into sporangial cells, producing true spores from which new filaments arise. This process appears to have been distinctly observed by Thuret in *Nostoc verrucosum*.

The three remaining families of this section are, strictly speaking, composed of unicellular plants—*i.e.*, consisting essentially of a single cell, which may be solitary or associated with others, in no very definite order, or as a brittle filament; cells multiplying by fission and reproducing by conjugation.

#### FAMILY IV.—*Palmellaceæ*. (PLATE IX.)

Green cells (often red), spherical or ovate, in a more or less consistent or definitely formed gelatinous material, constituting a frond, so called; the cells multiplying by simple fission, without gemmation. Of the numerous genera referred to this family, the following may be given as good examples—



Fron	{	Indefinite or formless .....	{ Mucoid, <i>floating</i> , with minute cells .....	(1.) MICROHALOA.
			{ Slimy, <i>encrusting</i> , with large globular cells .....	(2.) PALMELLA.
	{	More consistent and definite in form.	{ Globular, including numerous distinct cells .....	(3.) COCCOCHLORIS.
			{ Bandlike, simple, or branched, with cells in twos or fours in single series .....	(4.) HORMOSPORA.

Though the precise limits of the *Palmellaceæ* are yet but imperfectly defined, these plants are of considerable interest to the water analyst, they so frequently find their way into cisterns and reservoirs, and thus make their appearance in the deposits of drinking water. Several genera which would appear to be more correctly referrible to the *Volvocaceæ*, are usually confounded with them; and the accumulation of synonyms has only added to the confusion.

To illustrate multiplication by fission in the *Palmellaceæ*, we shall instance the genus *Coccochloris*, which will enable us to see what little more is required to meet the conditions observable in the *Desmidiaceæ* and *Diatomaceæ* respectively.

In *Coccochloris* (3 *a* and *b*) binary subdivision, with the successive formation of a cellulose and hyaline investment, seems to go on practically without limit, a fresh impetus to the process being given by the conjugation and blending of two endochromes (*c*), in which repeated fission goes forward as before. This is, in effect, also what takes place in the *Desmidiaceæ* and *Diatomaceæ*, and the observation is so far correct, even though *Coccochloris* and its allies should be, as some suppose, but the gonidia of Lichens in a certain phase of development.

#### FAMILY V.—*Desmidiaceæ*. (PLATE IX.)

These are unicellular plants, usually of an exceedingly rich green colour, nearly exclusively confined to fresh water, occurring singly, or remaining in contact after binary subdivision,

so as to form more or less brittle threads of cells in linear series. A sutural line running round the cell-wall transversely, marks it off into two symmetrical halves, and cleavage takes place at this line, preparatory to the gemmation of two new half frustules from the old ones thus separated. The forms of these cells are very beautiful and varied, and chiefly characterize the genera, which admit of the following arrangement:—

1. Cells separate.	Plain and much elongated— <i>Closteriæ</i> ...	Curved or crescentic .....		1. CLOSTERIUM.
				2. PENIUM.
		Straight	Ends rounded ... { Contents simple .....	3. SPIROTÆNIA.
			Contents spiral .....	4. DOCIDIUM.
			Ends truncated .....	5. TETMEMORUS.
	Ornamental, short, or of moderate length— <i>Cosmaricæ</i> .....	Deeply incised .....		6. MICRASTERIAS.
				7. EUASTRUM.
		Sinuated .....	Simple .....	8. COSMARIUM.
				9. ARTHRODESMUS.
				10. XANTHIDIUM.
		End view angular .....	Projections single ...	11. STRAUBASTRUM.
			Projections double ...	12. DIDYMOCLADON.
2. Cells forming filaments.	<i>Desmidiæ</i> .....	Cells oppositely bi-dentate ...	Filaments rounded ...	13. DIDYMOPRIMUM.
			Filaments angular ...	14. DESMIDIUM.
		Cells deeply constricted	Junction glandular ...	15. SPHEROZOSMA.
				16. HYALOTHECA.
		Cells slightly constricted	Junction perforate ...	17. APTOGONUM.
3. Cells in bundles, or loosely aggregated.	<i>Ankistrodesmicæ</i> .....			18. SCENEDESMUS.
				19. ANKISTRODESMUS.
				20. ANKISTRODESMUS.

FAMILY VI.—*Diatomaceæ*. (PLATE X.)

Like the former family, the *Diatomaceæ* are unicellular plants, in some instances isolated, in others cohering in chains or filaments, or in some definite way. The cell wall, however, is composed of a glassy or silicious material, instead of cellulose, which is found in all other vegetable cells; and the endo-

chrome is usually of a rich amber tint instead of green. They exhibit also much symmetry and beauty in the forms of the frustules, which are often so exquisitely sculptured as to afford excellent test objects for the microscope.

Each frustule consists of a new and an old half or valve, as noticed in the *Desmidiaceæ*, but the margins of the old valve overlap those of the new one, and thus results the so-called cingulum or "middle piece," which is not only capable of elongation by growth, but also by one portion sliding upon the other, telescope fashion, so as to make provision for the endogenous development of two new half frustules by fission and gemmation combined. From this arrangement it follows that the cells of each successive generation must be narrower than those within which they arise, by at least the whole thickness of the cell wall. Here then is the explanation of the great disparity of size so frequently observed in members of the same species. Moreover, we thus also see why it is that after the conjugation of two frustules, the resulting sporangial cell, in which the process just described commences, should be so much larger than the parent cells.

The genera of *Diatomaceæ* are too numerous to be separately defined in this treatise; but the annexed table, with the figures arranged in the same order, will assist in the recognition of the more usual fresh water forms:—

## CLASSIFICATION OF THE DIATOMACÆ.

Division 1. Not immersed or enveloped in a gelatinous frond.		Tribe 1. <i>Striatæ</i> . With linear sculpturing.		Without a median nodule.		<i>Eunotia</i> ... Areolate { Without terminal nodules ..... 1. EPITHEMIA.
						{ With terminal nodules { Separate ..... 2. EUNOTIA. { In a filament ..... 3. HIMANTIDIUM.
						<i>Meridioneæ</i> . Cuneate ..... { In a close spiral } 4. MERIDION.
						{ A close chain ..... 5. FRAGILARIA.
						<i>Fragilaria</i> æ. { Quadri-lateral... { Striæ granular { Single ..... 6. DENTICULA.
						{ Striæ continuous { In a close chain ... 7. ODONTIDIUM.
						{ Striæ scarcely visible { In a zigzag chain ... 8. DIATOMA.
						{ In a star-like chain 9. ASTRIONELLA.
						<i>Melosireæ</i> ... { Discoidal ..... Mostly single ..... 10. CYCLOTELLA.
						{ Cylindrical, or globose ..... In a filament ..... 11. MELOSIRA.
						<i>Surirella</i> æ ... { Subquadrate, ovate, or elliptical, with marginal furrows { Saddle-shaped ..... 12. CAMPYLODISCUS.
						{ Full border, simple 13. SURIRELLA.
						{ Depressed, borders undulate ..... 14. SPHINCTOCYSTIS.
						{ Much elongated ... { Compressed, with median puncta... 15. NITZSCHIA.
						{ Prismatic, with a pseudo-nodule ... 16. SYNEDRA.
						<i>Cocconeideæ</i> Elliptical ..... Fixed by one surface 17. COCCONRIS.
						<i>Achnantheæ</i> . Bent ..... { With a stalk ..... 18. ACHNANTHERS.
						{ Without a stalk ... 19. ACHNANTHIDIUM.
						<i>Cymbelleæ</i> ... { Inequilateral, not sigmoid ..... { Witbout a stalk ... 20. CYMBELLA.
						{ With a stalk ..... 21. COCCONEMA.
						<i>Gomphonemæ</i> Wedge-shaped ..... With a stalk ..... 22. GOMPHONEMA.
						<i>Naviculeæ</i> ... { Ends full & rounded { Striæ continuous ... 23. PINNULARIA.
						{ Ends more acute { Straight { Striæ dotted, without a stauros..... 24. NAVICULÆ.
						{ With a stauros, or transverse bar ... 25. STAURONEIS.
						{ Sigmoid { Striæ in both directions ..... 26. GYROSIGMA.
						{ Ovoid, inflated ..... 27. AMPHORA.
						<i>Striatella</i> æ... { Vittæ Simple but interrupted . { A close series... 28. TETRACYCLUS.
						{ Vittæ Capitulate, like notes in music... 29. TABELLARIA.
						{ Vittæ Capitulate, like notes in music... 30. TERPSINOE.
						{ Like <i>Navicula</i> { Hoops with loculi } Frond mamillated . 31. MASTOGLOIA.
						{ Hoops simple } Frond amorphous . 32. FRUSTULIA.
						{ Frond filamentous . 33. COLLETONEMA.
						{ Like <i>Cymbella</i> ..... Frond filamentous . 34. ENCYONEMA.

Division 2.  
Immersed, or enveloped in a gelatinous frond.



## GROUP II.

FAMILY VII.—*Volvocaceæ*. (PLATE XI.)

THIS family is sufficiently defined in the terms of Section II., and it will only be necessary to characterize the leading genera.

Motile or flagellate cells.	{	Numerous.	{	Single, two, or four in number, remaining united by incomplete cleavage .....	(1.) PROTOCOCCUS.
				Grouped by fours in larger cells on a gelatinous frond ..	(2.) TETRASPORA.
					(4.) PANDORINA.
			{	Mutually united by stolons, but originally distinct .....	In square tablets ... (3.) GONIUM.
					In spherical extensions (5.) VOLVOX.

The life history of *Protococcus*, so far as it has been traced out by Cohn and others, presents such a variety of conditions and stages that it is difficult to retain them in the memory. It presents, however, so close a relationship to *Volvox*, that it would be well to compare the two forms carefully and contrast both with *Pediastrum* and *Hydrodictyon*.

In one developmental stage of *Protococcus*, a motile cell encysted after a fashion, breaks up into four by cleavage, but frequently these remain united by their beaked extremity, when the cleavage has not been quite completed, thus producing a compound form strikingly suggestive of *Volvox*, which is simply a wider extension of a similar condition.

The *Volvox* sphere results from the segmentation of a single mass of endochrome, the ultimate subdivisions of which assume the flagellate motile character, and become organically united by the mutual blending of little stolon-like extensions, piercing the hyaline investments, which become hexagonal by

mutual contact and compression. This union also takes place in the cells of *Gonium*, while in numerous other *Volvocaceæ*, as in *Pandorina*, it never happens, but the cells simply lie in juxtaposition. As before intimated, the connexion of the four motile cells of *Protococcus* arises from the incomplete cleavage of the original cell, while the communication subsisting between the cells of *Volvox* and *Gonium* is sequential to complete cleavage.

The union of primary distinct elements to constitute what we must regard as the perfect organism is further seen in the *Pediatreeæ*, which are at present, obviously incorrectly, associated with the *Desmidiaceæ*, and in the remarkable genus *Hydrodictyon*, supposed to be siphonaceous. These are provisionally arranged by themselves in the next Section.

### GROUP III.

#### FAMILY VIII.—*Pediastraceæ*. (PLATE XI.)

*As defined in the preceding paragraph, including at least three genera.*

- |                                                                                        |                              |
|----------------------------------------------------------------------------------------|------------------------------|
| 1. Cells disposed in radiate discoidal fronds<br>always minute .....                   | } (1.) <i>Pediastrum</i> .   |
| 2. Cells like those of a <i>Pediastrum</i> , but<br>in a spherical frond .....         |                              |
| 3. Cells disposed in a reticulate saeculus,<br>often attaining a considerable size ... | } (2.) <i>Hydrodictyon</i> . |

In *Pediastrum* the form originates in the cleavage of an endochrome into two, then four, and finally some multiple of this, when a radial frondose expansion is formed by the juxtaposition, and union of the cells in some definite manner.

In *Hydrodictyon*, on the other hand, a motile cell breaks up into numerous distinct endoehlomes, which acquire a cellulose coat, and so arrange themselves as to form a reticulation of minute cylindrical cells, which gradually increase in size, and finally attain the character and dimensions they exhibit in the perfect plant. *Hydrodictyon* would therefore appear to hold a relationship to *Pediastrum*, similar to that which *Volvox* bears to *Gonium* or *Protococcus*. The latter organisms being made up of motile, and the former of ordinary vegetable cells.

#### FAMILY IX.—*Ulvaceæ*.

Plants composed of a single or double layer of green polyhedral cells, multiplying by fission, disposed in tabular or tubular frondose extensions, chiefly marine, but in some few instances occurring in brackish or fresh water.

The long tubular fronds of *Enteromorpha intestinalis* are sometimes found in fresh-water ditches, but perhaps more usually in brackish or salt water.

#### FAMILY X.—*Apiocystaceæ*.    *Siphonoid* (unicellular) *Algæ*.

(PLATE XI.)

The members of this family seem to be grouped with the *Palmellaceæ* as a matter of convenience. They are, however, quite distinct in their habits and relations. The fronds are composed of single cells, usually fixed at one end, and the reproductive elements are developed in the same cells, apparently engaging their whole contents. The following genera will serve for illustration :—

Plants	{ Non-parasitic, with green contents ...	{ Dehiscence irregular, slit-like	{ Pyriform, with gonidia in fours, forming nu- merous zoospores ... }	{ (1.) APIOCYSTIS.
			{ Fusiform, with a parie- tal starch granule and green contents, form- ing zoospores ... }	{ (2.) HYDROCYTIUM.
		{ Dehiscence subterminal, circumcissile	{ Cylindrical, curved, with 8 gonidia, which are dispersed when ripe . }	{ (3.) OPHIOCYTIUM.
			{ Cylindrical, straight, with 8 gonidia form- ing an umbel, like the parent cell, at its ex- tremity ..... }	{ (4.) SCIADIUM.
	{ Parasitic on Confervoids, with colourless contents .....		{ Globose, with a lid, growing upon cells and sending their pe- dicle inwards ..... }	{ (5.) CHYTRIDIUM.
			{ Flask-shaped, growing within cells and piercing the walls to discharge their go- nidia ..... }	{ (6.) PYTHIUM.

FAMILY XI.—*Siphonaceæ*. (PLATE XII.)

Fronds unicellular, or composed of a continuous extension of simple membrane, with the reproductive elements developed in special organs or cells.

Excluding such members of this family as are purely marine, only two fresh-water genera are worthy of special notice here—viz., *Vaucheria* and *Achlya*.

(1 to 4.) *Vaucheria*. Most of the species of this genus are inhabitants of fresh water; but some are marine. They consist of branched tubular filaments, frequently almost felted together in fine silky green tufts. The little granules of chlorophyll in the interior of the filaments are for the most part applied to the walls, embedded in a colourless protoplasm. *Zoospores* are formed in the club-shaped ends of the filaments. Unger observed that these bodies usually made their escape about eight o'clock A.M., at which time the process may be



observed in healthy plants cultivated in fresh water. A true sexual mode of reproduction also exists in *Vaucheria*. Of the numerous species of this genus that have been described it would appear that only two or three are reliable. 2, portion more highly magnified; 3, reproductive organs; 4, *a*, *b*, and *c*, stages of development of the ciliated spore.

(5.) *Achlya prolifera* is a small colourless plant, consisting of clavate erect tubular filaments springing from a mycelium-like minutely ramified base, closely applied to the bodies of dead flies in water, fish and frogs, upon which they grow parasitically. It was originally mistaken for the common fly fungus, or an aquatic form of *Botrytis Bassiana*, but more recent researches, rewarded by the discovery of ciliated zoospores, and of a perfect sexual system like that of *Vaucheria*, have dispelled these views and given the plant what would appear to be its true position. Apropos of the want of colour in this parasitic form, it will be noticed that *Chytridium* and *Pythium*, which are parasitic genera, in the preceding family, are also without colour.

## FAMILY XII.—*Zygnemaceæ*. (Plate XII.)

Plants consisting of cylindrical articulated filaments, with the green contents usually disposed in elegant patterns. Reproduction is effected by the phenomenon of conjugation, the whole contents of each pair of united cells being converted into a spore. The particulars of the manner in which this process takes place will be seen in the definitions of the following genera:—

Conjugating.	By transverse tubes between the neighbouring cells of different filaments.	Spore, formed in one of the parent cells.	Endochrome spiral ...	(1.) SPIROGYRA.
			Endochrome in two round or stellate masses.....	(2.) ZYGNEMA.
		Spores formed in the connecting tubes.	Endochrome in two round or stellate masses .....	(3.) ZYGOGONIUM.
			Spore rounded; endochrome diffused .....	(4.) MESOCARPUS.
			Spore square or cruciate; endochrome diffused .....	(5.) STAUROCARPUS.
	By an arcuate tube between neighbouring cells of the same filament.	Spores formed in one of the parent cells.	Spore ovoid; endochrome spiral .....	(6.) RHYNCHONEMA.
		Spores formed in the connecting tube.	Endochrome diffused...	(7.) PLEUROCARPUS.*

1, 2, and 3, *a.* Original filament; *b.* Conjugation; 5 and 6, *a.* and *b.* Different species.

\* Not figured.

### FAMILY XIII.—*Confervaceæ*. (Plate XIII.)

Plants composed of cylindrical cells forming articulated filaments, simple or branched, with a very delicate gelatinous coat. The cell contents are usually green, rarely brown or purple, often assuming peculiar patterns, and ultimately converted into Zoospores, with two or four cilia, from which the filaments are reproduced.

From a fresh-water point of view, only three genera appear to be of importance—viz., *Cladophora*, *Rhizoclonium*, and *Conferva*; and even these may all be yet included in the succeeding family.

All the species with branching filaments may be referred to the genus *Cladophora*; for though many species of *Rhizoclonium* have short root-like branches, it so happens that those found in fresh water have simple filaments, which are best distinguished by their decumbent habit from the simple filaments of *Conferva*.

*Cladophora glomerata* occurs in dark green wavy skeins in pure running water, and  
 „ *crispata* (*b*) in yellowish or dull green strata, is common in fresh, though frequently also in brackish, water.

*Rhizoclonium rivulare* is found in fine bright green bundles, 2–3 feet long, in streams and rivers, &c.

„ *implexum* on mountain rocks.

*Conferva bombycina*. Cells four or five times as long as broad in a yellowish green cloudy stratum in stagnant water.

„ *floccosa* (*a*). Cells once or twice longer than broad, with circumscissile dichiscence, everywhere common in pools and still water.

#### FAMILY XIV.—*Edogoniaceæ*. (Plate XIII.)

Articulated filamentous plants, simple or branched, exhibiting much variety in their means of reproduction. Thus, the whole contents of a cell produce zoospores with a rich growth of cilia, and sporangial cells develop large resting-spores; while antheridial structures are present either on the ordinary filaments or in dwarf parasitic plants. The filaments grow by a rather peculiar process, commencing with circumscissile division of the cellulose coat of the interstitial cells, which thus permits of the growth or extension of the primordial utricle, or under coat, and the formation of a new septum. A cementing band of cellulose repairs the gap between the divided borders of the parent cell, leaving an annular impression to record the fact, and the repetition of the process pro-

duces a repetition of the rings, which always characterize even fragments of these plants.

The two genera are easily distinguished, the filaments of *Ædogonium* (*c*) being simple, and those of *Bulbochæte* (*d*) branched and bearing bristle cells with a bulbous base.

The species of *Ædogonium* abound in fresh water under almost all conditions, in lakes, ponds, pools, ditches, streams, and in tanks and cisterns. *Bulbochæte setigera* (*d*), apparently the only reliable species of the genus, grows luxuriantly upon other fresh-water plants.

#### FAMILY XV.—*Chætophoraceæ*. (Plate XIII.)

These are very beautiful, branched and articulated, filamentous plants, enveloped in gelatinous matter, and made up of cells in single series. Some are free, with a straight central axis; while others are fixed with depressed radiating branches, or forming a discoidal frond. The tapering extremities of the branches in some instances are quite bristle-like, affording one of the distinctive characters of the family. Bristles of an inarticulate kind, however, arise from the articulations in certain genera. Finally, spores and four-ciliated zoospores are formed from the contents of the joints.

*Draparnaldia* presents a central axis of large colourless cells, with tufts of smaller branches at the articulations. In *Chætophora* (*c*) the filaments are branched and setigerous, indefinitely embedded in gelatinous matter. In *Coleochæte* the frond is discoidal and adherent, composed of radiating dichotomously branched filaments and the bristles springing from the back of the joints are sheathed at the base.



FAMILY XVI.—*Batrachospermaceæ*.

These plants are evidently very closely allied to the *Chætophoraceæ*, and the name is derived from the resemblance which their beaded filaments have to frog's spawn. The central axis consists of a single series of cells, with an investment of adpressed filaments descending from joints or nodes, occurring at stated intervals, and also giving rise to dense whorls of exceedingly delicate moniliform branches. Some of these latter produce spores at their extremities, whilst others form transparent capillary points. The spores form agglomerated masses at the nodes.

In *Batrachospermum* the ramuli are moniliform, while in *Thorea* they are cylindric. These plants are exclusively aquatic, but chiefly found in pure and gently running water.

FAMILY XVII.—*Characeæ*.

In this interesting family, while the vegetative apparatus is of a very simple type, the generative system is more highly developed than that of any of the preceding forms. These plants consist of a number of large tube-like cells, forming a central axis, and whorls of similar, but smaller cells at the nodal points. So far, this description will answer the genus *Nitella*, which may attain a length of several inches; but in *Chara* an additional envelope is furnished to the central stem by closely applied tubular cells passing from the nodes in both directions, and meeting at the middle of the internodes.

The antheridia and germ cells are here respectively named *globules* and *nucules*. Eight triangular valves radially fluted, and numerous confervoid filaments with antherozoids in the

cells, make up the globule; while fine spirally-twisted tubes form the investment of the nucleolus. So short a notice of these organs is only given to facilitate their recognition when detached.

*Notes on the habitat of the Fresh-water Algæ, in relation to the import of their presence in drinking water under examination.*

It is important to know that, not only is there a general geographical distribution of aquatic plants in the larger districts of the globe, but also a more restricted localization of certain species, by mere casualty; whilst the special habitat of others is determined by the fulfilment of conditions most favourable to their modes of development and habits of life. Thus, some may be found in running or gently moving water, some in still depths, some in the pool, the pond, the lake; others in the streamlet, the brook, the river; some in regions of death and decay, and others with purer surroundings. There would therefore appear to be good promise in the study of this department of Botany, including not only the recognition of any organisms that may reveal themselves, but the hygienic import of their presence.

The *Palmellaceæ*, *Coccochloris*, *Chlorococcum*, &c., appear to depend largely upon the rains, both for their propagation and diffusion, and the moisture surrounding them must be sufficiently persistent to favour the development of their outer gelatinous investment. In the absence of the requisite moisture and consequently of the gelatinous envelope, these humble plants present the appearance of a green efflorescence. How far they may invade Lichens, as casual parasites mistaken for gonidia, is yet an unsettled question.

While the *Desmidiaceæ* are, perhaps with very few exceptions, essentially aquatic, the more striking forms of *Diatomaceæ* are marine. As Desmids seem to love pure water, and usually

rest mechanically upon the placid bottom of such spots as are not affected by the constant motion or change going on in their immediate vicinity, their presence might be regarded as a favourable indication.

The *Diatomaceæ* are more widely diffused than any other form of vegetation. They flourish both in standing and running water, and even on the bare ground. In South America some take up their abode amongst lichens upon the trunks of trees. Certain species moreover are found in thermal springs, and others in the pancake ice of the South Pole.

*Bacteria* are so invariably associated with the decomposition, or rather putrefaction of animal and vegetable matter, that this change is supposed by many to be incapable of taking place without their presence and rapid development.

The *Oscillatoriaceæ* are ubiquitous as a family, though many of them are very definitely distributed; thus, the *Rivulariæ* appear to be confined to Northern regions. They are often found on the stumps of aquatic plants, on rocks in rapid streams, and sometimes where they are exposed to the force of cataracts. They frequently also indicate calcareous water, and crystals of carbonate of lime may be deposited in their substance. A very pretty species presents the appearance of minute green stars upon the surface of lakes. In India *Oscillatorians* ascend to 17,000—18,000 feet above the level of the sea. The *Zygnemaceæ* reach a height of 15,000 feet amongst the Himalayas. They are found in rivers and running waters. The *Confervaceæ* occur in similar situations, but their habitat is in general more varied.

*Siphonaceæ* (*Vaucheria* for example) form large tufts in mud whether impregnated with salt or fresh water; they also abound in pools and damp soils. *Codium amphibiorum* affects turf banks at high water, and other members of the family are altogether marine.



*Chætophoraceæ* and *Batrachospermaceæ* occur in gently moving pure water, of which their presence would therefore afford some indication.

*Characeæ* inhabit still, rather than moving water. One of the species may be met with in brackish ditches, and the occurrence of these plants can scarcely be regarded as a guarantee of the purity of the water. Many of them however have the property of fixing carbonate of lime, by which they have acquired the name of "stoneworts."

### B. *Living Animals.*

The smaller, or microscopic Fauna of the fresh water, as might be expected, is rather comprehensive, including representatives of all the sub-kingdoms and many of the classes of Invertebrata. This will be seen at a glance in the annexed Table, the arrangement of which will be followed in the succeeding pages.

To facilitate the recognition of objects under examination the following definitions of the five sub-kingdoms should be carefully studied, after which it will be found comparatively easy to refer each organism to its proper position in the Table—noting that the definitions apply more particularly to the fresh-water forms.

I. The *Protozoa* (Siebold) are small or minute bodies, either more or less partaking of the character of simple cells, furnished with vibratile cilia or flagella; or resembling merely the contents of cells, destitute of an integument, but capable of throwing out mobile extensions of the sarcode, or gelatinous substance of their bodies. The members of this latter class are named *Rhizopoda*, from the root-like form of the locomotive processes, while those of the former constitute the *Infusoria*, so abundant in organic infusions.

II. The *Cœlenterata* (Frey and Leuekart) are distinguished by having the lining membrane of the stomach continuous with that of the body cavity. They are represented by the single class *Hydrozoa*, including the *Fresh-water Polypes*.

III. The *Annuloida* (Huxley) embrace all the worm-like animals which are not true *Annelida* and the Wheel animals. Thus, in the Table the class *Scolecida* (σκώληξ, a worm) includes the ciliated Flatworms (*Turbellaria*), the Threadworms (*Nematoda*), and the Rotifers (*Rotifera*).

IV. The *Annulosa* are distinctly ringed, or segmented animals. They are divided into two classes—viz., those which are without articulated limbs (*Anarthropoda*), including only the *Annelida*; and those which have articulated limbs (*Arthropoda*). The latter are still further divided into the *Crustacea* (with limbs varying in number), the *Arachnida* (or spiders with eight limbs), and the *Insecta* (or insects proper, with six limbs).

V. The *Mollusca*, as the name implies, are soft-bodied animals, usually protected by a testaceous covering or shell. They are divided into an inferior class (*Molluscoida*) taking in the *Limniades* or fresh-water *Polyzoa*, and a superior one (*Mollusca* proper), represented by the fresh-water snails and mussels, or shellfish so-called.

As all the classes have been named and sufficiently characterized in the foregoing definitions, attention may next be directed to the Orders and the illustrative, or more usual genera.

In order to present a bird's-eye view of the subject to the student, the following Table of Classification has been drawn up, with short definitions of the technical terms employed.

*A General Table of Classification of Animal Forms, with short Explanatory Notes embodied.*

Sub-Kingdom.	Division.	Class.	Sub-Class.	Section.	Order.	Genus.
I. PROTOZOA .... (The first, or simplest forms of animal life.)		1. <i>Rhizopoda</i> ..... (Like the contents of a cell, throwing out and retracting root-like variable extensions of the body, named pseudopodia.)			(a) Radiolaria ..... (Pseudopodia radiate.)	ACTINOPHRYS.
					(b) Reticularia..... (Ps. reticulate.)	GEOMIA.
					(c) Lobosa ..... (Ps. lobed or digitate.)	AMEBA.
					(d) Spongida ..... (Sponges.)	SPONGILLA.
II. COELENTERATA .... (Stomach and body-cavity in communication = Polypes.)		2. <i>Infusoria</i> ..... (Cell-like, with locomotive whip-like organs, or cilia.)			(a) Flagellata ..... (With whip-like organs.)	PERANEMA.
					(b) Ciliata ..... (With cilia.)	PARAMECIUM.
					(a) Hydrida ..... (Hydra-like.)	HYDRA.
					(b) Corynida..... (Coryne-like.)	CORDILOPHORA.
III. ANNULOIDA... (Like Annulosa.)		1. <i>Scolecida</i> ..... (Worms.)	A. <i>Hydroïda</i> ..... B. <i>Nematelmia</i> ..... C. <i>Rotifera</i> ..... (Wheel animalcules.)		(a) Turbellaria ..... (Ciliated worms.)	PLANARIA.
					(b) Nematoda ..... (Smooth thread-worms.)	ANGUILLULA.
					(c) Rotifera ..... (Wheel animalcules.)	ROTIFER.
					(a) Hirudinea ..... (Leeches.)	GLOSSIPHONIA.
IV ANNULOSA ... (Ringed or segmented.)	A. ANARTHROPODA... (Limbs inarticulate.)	1. <i>Annelida</i> ..... (Body ringed.)		A. <i>branchiata</i> ..... (Without branchia.)	(b) Oligochata ..... (Few bristled.)	NAIS.



## I. PROTOZOA.

1. *Rhizopoda*. (PLATE XIV.)

Besides the *sponges*, which are represented by the genus *Spongilla* (found in still or slowly running waters, on stones, old workwork, &c.), the *Rhizopoda* admit of distribution into three groups, easily distinguishable by the characters of the *pseudopodia*, or the motile extensions of the body substance already noticed. In the first group or order (*a*) (*Radiolaria*) they are slender and raylike, persistent, or slowly retractile. In the second (*b*) (*Reticularia*) they are firmly branched, more or less intercommunicating, or reticulate; while in the third (*c*) (*Lobosa*) they are lobose or digitate. These Orders correspond very nearly with those adopted by Dr. Carpenter, F.R.S., and will be better understood on inspecting the following synopsis of the genera. They have the advantage, at least, of being simple, though of course they can only be provisional in the present state of our knowledge of the subject.

(*a*) *Radiolaria*.

*Pseudopodia* delicate ray-like simple, besetting the spherical surface.

Body	{	Naked .....	(1.) ACTINOPHRYS.
		With fine spiculæ; free ...	(2.) ACANTHOCYSTIS.
	{	With a covering or shell { Fenestrated; with a pedicle	(3.) CLATHRULINA.

*Habitat*:—*Actinophrys digitata* amongst marsh plants; *A. Eichornii* on the surface of infusions, and with *A. discus* (*Trichodiscus*) and the other species, amongst confervæ and aquatic plants. *Acanthocystis* and *Clathrulina* occur in bog-water.

(*b*) *Reticularia*.

*Pseudopodia* filiform, reticulate, or finely branched; localized, (Body) globose or ovoid.



Pseudo- podia.	{	Closely reticulated ; sarcode reflected over the shell ...	(1.) GROMIA.
		Finely branched in a bunch {	At one end .. (2.) PLEUROPHRYS.
			At both ends ..... (3.) AMPHITREMA.

*Habitat* :—*Gromia fluviatilis* on *Ceratophyllum*, *G. hyalina* (with a short neck) in rivulets. *Pleurophrys* and *Amphitrema* in bog-water.

(c) *Lobosa*.

*Pseudopodia* lobose or digitate, simple or dividing.

Body {	{	With a covering or shell {	{	Pseudopodia, fine and simple, shell flask-shaped ..	Two or three ; subterminal..	(1.) TRINEMA.
				Pseudopodia, stout and dividing ..	Numerous ; terminal ..	(2.) & (3.) EUGLYPHA.
					Shell flask-like .	(4.) DIFFLUGIA.
				Pseudopodium single ...	Shell discoidal...	(5.) ARCELLA.
					Shell subcubical	(6.) CYPHIDIUM.
Naked ...	{	{	{	Pseudopodia, variable ..	.....	(7.) AMÆBA.

*Habitat* :—*Trinema acinus* and *Euglypha tuberculata* in stagnant water ; *Diffugia proteiformis* and *oblonga* amongst *Oscillatoriaceæ* ; numerous other species in moist moss at the roots of trees ; *Arcella vulgaris* with *Lemnæ* and aquatic plants, *A. aculeata* and *A. dentata* with *Conservæ* ; *Cyphidium aureolum* in stagnant water ; *Amæba diffuens* on *Lemna* and *A. radiosa* in bog-water.

(d) *Spongida*.

*Spongilla*, the only fresh-water genus, occurs in little grey or greenish more or less rigid or friable masses, with a spicular framework. They present a superficial or dermal coat, numerous inhalant pores, internal ciliated chambers, and an exhalant aperture. Their grey or green colour is due to the amount of chlorophyll taken into the sarcode or soft substance of the sponge. The silicious spicules which are often present in





*Habitat* :—The *Monadina* are usually found in animal and vegetable infusions, in decomposing water, and especially amongst decaying fresh-water Algæ. *Euglena viridis* abounds in pools, and like *Phacus*, which also affects stagnant water, often imparts its green tint to the surrounding medium. Though the *Peridinæa* may occur in stagnant ponds, they are not to be found in decomposing water or infusions.

(b) *Ciliata*.

Furnished with vibratile cilia, variously distributed, either as connected with the mouth, or the general surface.

*Families and Illustrative Genera.*

1. Integument non-contractile.	Naked	{	No apparent mouth; cilia scattered	ENCHELIA. (Enchelys; Alysacum.)	
			{	Without cirrhi .....	TRICHODINA. (Trichoda; Trachelius.)
				With cirrhi also ...	KERONIA. (Kerona; Halteria.)
	With a carapace (diffuent) .....	EUPLOTA (Ehr.). (Euplotes; Himantophorus.)			
2. Integument lax, with serially disposed cilia.	Free .....	{	No oral fringe .....	PARAMECIA. (Paramecium; Pleuronema.)	
			With an oral fringe.	BURSARINA. (Bursaria; Leucophrys.)	
	Fixed.....	{	Voluntarily .....	URCEOLARINA. (Urceolaria; Stentor.)	
			By special organs...	VORTICELLINA. (Vorticella; Epistylis.)	

*Habitat* :—The notable presence of the *Ciliata* would indicate not only stagnant water, but such as may contain organic matter in solution to some relative extent, not yet precisely determinable. Some *Paramecia*, however, as *Amphileptus*, are found in clear marsh water and streams running between aquatic plants. Some *Enchelia* and *Keronia* occur in water with decomposing vegetable matter; and the *Vorticellina* also abound in vegetable infusions, though several are parasitic on *Entomostraca* in comparatively good water.

Some *Bursarina* present themselves in the intestine of the Frog, and of *Nais*; and *Urceolaria pediculus* may be seen gliding over the ciliated surface of *Planaria* (see also the note appended to the Table of the species of *Hydra* below).

The following Tables of classification will form the most convenient description of the figures.

*Flagellata. Monadina. (PLATE XIV.)*

Iso- lated.	A single flagellum ...	Arising in front	{ Mobile throughout... 1. MONAS.
			{ Mobile at the end ... 2. CYCLIDIUM.
		Arising just behind the beak ...	3. CHILOMONAS.
	A second filament ...	Arising laterally .....	4. AMPHIMONAS.
		Posteriorly .....	5. CERCOMONAS.
		In front, but trailing .....	6. HETERAMITA.
Aggre- gate.	Two equal filaments at the curved angles in front.....		7. TREPOMONAS.
	Four equal filaments in front, and two thicker ones posteriorly .....		8. HEXAMITA.
	Group originally fixed on a branched axis .....		9. ANTHOPHYSA.
	Group always free, revolving .....		10. UVELLA.

*Dinobryina.*

With an urceolate carapace.	Single, without an eye-speck, and commonly without a flagellum .....	1. EPIPTYSIS.
	Forming a branched aggregate, with both eye-speck and flagellum .....	2. DINOBRYON.

*Euglenia.*

Attached .....		1. COLACIUM.
Free.....	No visible flagellum; two eye-spots .....	2. DISTIGMA.
	One flagellum {	With an eye { With a tail-like process 3. EUGLENA.
		{ Without a tail ..... 4. AMBLYOPHIS.
		Without an eye ..... 5. PERANEMA.
	Two flagella .....	{ Green or red; an eye-spot 6. CHLOROGONIUM.
		{ Colourless; no eye-spot 7. ZYGOSELMIS.
	Several flagella.....	8. POLYSELMIS.

*Thecamonadina.* (PLATE XV.)

Flagellum	{ Single	{ Body ovoid or globular	{ Integument hard ...	1. TRACHELOMONAS.
			{ Integ. membranous	2. CRYPTOMONAS.
		{ Body depressed or folia- ceous ..... ..	{ With a tail .....	3. PHACUS.
			{ Without a tail ....	4. CRUMENULA.
	{ Two, one trailing .....		5. ANISONEMA.	

*Peridinæa.*

Carapace...	{ Setaceous .....	{ With an eye-spot ...	1. CHÆTOGLENA.
		{ No eye-spot .....	2. CHÆTOTYPHLEA.
	{ With a ciliated furrow ...	{ With an eye-spot ...	3. GLENODINIUM.
		{ No eye-spot .....	4. PERIDINIUM.

*Ciliata.—Enchelia.* (PLATE XV.)

Body..	{ Partially ciliated ...	{ Cilia at one end .....	1. ACOMIA.
		{ Cilia in a longitudinal furrow	2. GASTROCHÆTA.
	{ Ciliated all over .....	{ Cilia all alike .....	3. ENCHELYS.
		{ With a trailing filament also	4. ALYSCUM.

*Trichodina.*

Cilia	{ Covering the body .....	{ Forepart curved like a hatchet .....	1. PELECIDA.
		{ Neck long and slender .....	2. DILEPTUS.
		{ Upper lip prolonged into a proboscis ...	3. TRACHELIUS.
	{ In front, chiefly .....	{ On one or both sides directed forwards ...	4. ACINERIA.
		{ In one row, directed backwards .....	5. TRICHODA.

*Keronia.*

Having styles .....	{	{	{	{
„ cirrhi				
„ cilia	{	{	{	{
„ setæ				
„ uncini .....				

*Euplota.*

- Body depressed { Having hooks but no styles ..... 1. HIMANTOPHORUS.  
 { With both styles and hooks ..... 2. EUPLOTES.

*Paramecia.* (PLATE XVI.)

- Teeth present { Mouth lateral } ..... Body { Lamelliform, frontal margin } 1. CHILODON.  
 { Mouth terminal } ..... Body { produced on one side ..... } 2. NASSULA.  
 { Mouth terminal } ..... Body { Globular ..... } 3. PRORODON.
- Without teeth. { Mouth lateral } { With ap- pendages { With vibrating lips ..... 4. GLAUCOMA.  
 { Without appendages { Lip inferior, projecting ..... 5. COLPODA.  
 { Mouth within a longitudinal } 6. PARAMECIUM.  
 { oblique fold ..... } 7. PANOPHRYS.  
 { Mouth impinging on the margin } 7. PANOPHRYS.
- { Mouth terminal } ..... Body { Globular by contraction ..... 8. HOLOPHRYA.  
 { Flask- shaped. { Pointed behind..... 9. TRACHELOCERA.  
 { Rounded behind ..... 10. LACRYMARIA.

*Bursarina.*

- Body { Short purse-like { Acuminate posteriorly, with a fron- } 1. OPHRYOGLENA.  
 { or moderately { tal eye-spot ..... } 2. BURSARIA,  
 { elongated..... { Rounded posteriorly, no eye-spot ; } and  
 { a spiral row of cilia in front, end- } 3. LEUCOPHRYS (Ehr.)  
 { ing in a large mouth ..... } 4. SPIROSTOMUM.  
 { Much elongated, { Mouth in advance of the middle, at }  
 { cylindrical ... { the end of a row of cilia ..... }

*Urceolarina.*

- Clustered vorticella-like animals in gelatinous masses ..... 1. OPHRYDIUM.
- Solitary { With a crown of { Body short and discoidal ..... 2. URCEOLARIA.  
 { cilia at both ends } 3. STENTOR.  
 { Crown of cilia in { Body trumpet-shaped, ciliated all }  
 { front only ... { over, mouth spiral ..... } 4. UROCENTRUM.  
 { Body bell-shaped, smooth ; tail sub- }  
 { ulate ..... }

*Vorticellina.*

Stalk present.	{ Bodies all uniform ...	{ Stalk spirally flexible	{ Simple ...	1. VORTICELLA.
			{ Branched	2. CARCHESIUM.
	{ Bodies of two shapes	{ Stalk inflexible .....		3. EPISTYLIS.
		{ Stalk spirally flexible.....		5. ZOOTHAMNIUM.
		{ Stalk inflexible .....		4. OPERCULARIA.

*Symmetrical Forms.* (PLATE XVII.)

The genera (1) *Ichthydium*, (2) *Chætonotus*, (3) *Coleps*, and (4) *Planariola* are placed by Dujardin as an appendix to the Ciliata, though they have no natural affinity *inter se*, on account of exhibiting a bilateral symmetry, which singularly enough, is wanting in all the other ciliated Infusoria.

II. CŒLENTERATA. (PLATE XVII.)

The only *Cœlenterata* occurring in fresh water are members of the sub-class *Hydroida*, the two first orders of which—viz., *Hydrida* and *Corynida*, are represented by the respective genera *Hydra* and *Cordylophora*.

(a) *Hydrida.*

The first Order is distinguished by the Polypites or separate Zooids being single and locomotive, with a sucker disc at one end, and an oral orifice at the other, surrounded with tentacula. The integument never develops a sclerous layer, and the reproductive organs appear as simple external processes of the body.



Table of the species of the genus *Hydra*.

Body	Cylindrical or insensibly narrowed towards the base.	Tentacula shorter than the body, smaller at the base.....	(1.) <i>H. viridis</i> . (Leaf green.)
		Tentacula as long as or longer than the body, tapering to the end ...	(2.) <i>H. vulgaris</i> . (Yellowish or red.)
	Attenuated below in a marked degree.	Tentacula longer than the body ...	<i>H. attenuata</i> . (Pale olive green.)
		Tentacula several times longer than the body .....	<i>H. fusca</i> . (Brown or greenish.)

*Habitat* :—In ponds and still waters on *Lemna* and aquatic plants.

*Note*.—Parasitic Infusoria are often found upon these Polypes—viz., *Kerona polyporum* or *H. vulgaris* and *H. fusca*; and *Urceolaria pediculus* or *H. vulgaris* and *H. viridis*. Their presence, however, would indicate impurity of the water and an unhealthy condition of the Polypes themselves.

(b) *Corynida*.

In this, the second order, the Polypites are either single or two or more connected by a common substance or “*Cœnosarc*,” always fixed at the base, and usually developing a firm outer layer or “*Polypary*.” The reproductive organs or “*Gonophores*” arise either from the Polypites, the *Cœnosarc*, or the so-called “*Gonoblastidia*.”

Genus *Cordylophora* (Allman.)

Polypary horny, branched, and rooted by a creeping tubular stolon; polypes ovoid, with a small mouth, and scattered filiform tentacula.

(3.) *Cordylophora lacustris* was the only species known to Allman, but lately a second, *C. rivularis*, has been added.

III. ANNULOIDA.

1. *Scolecida*.

(a) *Turbellaria*. (PLATE XVII.)

Non-parasitic ciliated worms. Some of these are bisexual, with a single alimentary or oral opening, and constitute the first sub-order (*Planarida*), including fresh-water species, whilst others are unisexual, with two alimentary openings, and form a second sub-order (*Nemertida*) altogether marine.

*Planarida*.

		Illustrative Genera.
Intestine	Straight— <i>Rhabdocæla</i>	Concatenated ..... (1.) DEROSTOMUM.
		Single { Mouth near the fore part . (2.) PROSTOMUM.
	Ramosé— <i>Dendrocæla</i>	{ Mouth near the middle ... (3.) MESOSTOMUM.
		..... (4.) PLANARIA.

*Habitat*:—All in ponds and gently moving deep water amongst aquatic plants.

(b) *Nematoda*. (PLATE XVIII.)

The non-parasitic threadworms composing the family of *Anguillulidæ* are very frequently met with in fresh waters. The vinegar eel (*Anguillula aceti*), and sour paste eel (*A. glutinis*), and the *Tylenchus* (or so-called *vibrio*) *tritici*, invading the ears of corn, belong to this family. *Anguillula fluviatilis* is colourless or white, about fifteen times as long as it is broad, with a fusiform œsophagus, expanding posteriorly into a much larger stomach. 1, *Anguillula* found in bilge-water; 2, *A. aceti*; 3, *A. fluviatilis*.

The *Anguillæ* are readily confounded with the *Enoplidæ*, a family of minute parasitic *Nematodes*, infesting the intestine of aquatic larvæ and other small animals, but often found free in the water.



(c) *Rotifera*. (PLATE XVIII.)

The Wheel Animalcules, so called on account of the deceptive appearance produced by the regular and consecutive action of the vibratile cilia fringing the head-lobes. These latter may be simple, sinuated, lobed or divided, and are capable of retraction and protrusion. The alimentary system is usually distinct, with a dental apparatus and two orifices, and the sexes are separate.

As a whole these little creatures present superficial points of resemblance to the *Entomostraca*, to which the character of their segmentation makes a nearer approach than that of any *Annelida*. Indeed, they have been rather appropriately named *Cilio-crustaceans* by Leydig. Dujardin grouped them in the following simple manner:—

*Illustrative Genera.*

1. Those that are fixed ... *Floscularia*. *Melicerca*.
2. Those that swim only ... *Brachionus*. *Furcularia*. *Albertia*.
3. Those that both swim  
and crawl ..... } *Rotifer*.

Ehrenberg's arrangement, though perhaps more artificial, may still be found more convenient for the recognition of genera.

*Rotifera.*

Sections.	Divisions.	Families and Illustrative Genera.
I. <i>Monotrocha.</i> Wheel organ simple .....	1. <i>Holotrocha.</i> Margin entire—carapace .....	{ Absent— <i>ICHTHYDINA</i> .* Ichthyidium podura.
		{ Present— <i>ECISTINA</i> . (1.) <i>Ecistes crystallinus</i> .
	2. <i>Schizotrocha.</i> Margin sinuous—carapace ...	{ Absent— <i>MEGALOTROCHÆA</i> . (2.) <i>Megalotrocha flavicans</i> .
		{ Present— <i>FLOSCULARIÆA</i> . (4.) <i>Floscularia ornata</i> .
II. <i>Sorotrocha.</i> Wheel organ divided ...	1. <i>Polytrocha.</i> Into several parts—carapace	{ Absent— <i>HYDATINÆA</i> . (5.) <i>Hydatina senta</i> .
		{ Present— <i>EUCHLANIDOTA</i> . (3.) <i>Monostyla quadridentata</i> .
	2. <i>Zygotrocha.</i> Into two parts—carapace ...	{ Absent— <i>PHILODINÆA</i> . (6.) <i>Rotifer vulgaris</i> .
		{ Present— <i>BRACHIONÆA</i> . (7.) <i>Brachionus amphiceros</i> .

\* Ichthyidium podura and Chætonotus larius will be found amongst the symmetrical Infusoria (Plate XVII., 1 and 2), to which Dujardin has referred them. Their true position, however, has scarcely yet been determined.

IV. ANNULOSA.

A. *Anarthropoda.* 1. *Annelida.* (PLATE XVIII.)

(a) *Hirudinea.*

All the Leeches have a more or less sucker-like mouth, and are also furnished with a disk-shaped caudal sucker; and although the body is finely annulated, it is divided into larger somites or segments like other annelida. The nervous system is highly developed, and the sexes are combined in the same individual; but neither self-impregnation nor reproduction by fission or gemmation has been observed in any case. The fresh-water types may be thus arranged:—

Eyes	{	10 in number	{	With jaws and teeth, but no proboscis .....	{	... <i>HIRUDO</i> .	<i>Illustrative Genera.</i>
{	Less than 10	{	{	With no teeth or proboscis ...	{	(2.) <i>NEPHELIS</i> and <i>BDELLIA</i> .	
	{	{	{	With proboscis, but no teeth .	{	(3.) <i>GLOSSIPHONIA</i> .	

*Habitat*:—In ponds and lakes and slowly-moving waters.

(b) *Oligochæta*.

The *Oligochæta*, or *Setigera*, include the *Earthworms* (*Lumbricini*) and the true water worms (*Naididæ*). Their bodies are usually much elongated, and furnished with locomotive chitinous setæ or bristles attached in rows to the sides and ventral surface laterally. The *Lumbricini* are hermaphrodite, and the *Naididæ* unisexual, but the latter also multiply in a remarkable way by gemmation and fission.

		Illustrative Genera.
1. <i>Lumbricini</i> . (Terrestrial and aquatic.)	Having four rows of setæ, two dorsal and two ventral, on each side	... TUBIFEX.
2. <i>Naididæ</i> . (All aquatic.)		
	Two rows of setæ, one dorsal and one ventral, on each side; the four first segments without dorsal setæ	(1.) NAIS.
	With ventral setæ only	... CHÆTOGASTER.

In Lamarck's genus *Stylaria* the setæ are very long, and the cephalic segment is produced into a kind of proboscis. The genus *Proto*, founded by Oken, is distinguished by the presence of ciliated tentaculiform processes surrounding the dorsal and subterminal vent, as in Fig. 1 a.

*Habitat* :—All these little worms live amongst aquatic plants, burrow in the mud, or manufacture little tubes into which they retreat for protection. The setæ, but more especially the ventral uncini (1 b), which are usually bifid at the extremity, are frequently found in the sediment of water in which algæ have been kept for some little time.

*Note*.—In some instances two speck-like eyes are present, and they may be confounded with the aquatic larvæ of insects. They differ, however, in having the setæ implanted beneath the general surface, and the absence of the fine dark ramifications of the trachææ and of oral or cephalic organs of any kind, except the above-mentioned eye-specks.

B. *Arthropoda*.

1. *Crustacea*.

A. *Entomostraca*. (PLATE XIX.)

The first four out of the six orders of Crustacea bearing aquatic genera belong to the sub-class *Entomostraca*, which may be said to consist of an empirical assemblage of usually very small or minute crustaceans, having either less than seven, or more than ten pairs of legs. To this it must be added, that the branchiæ are either attached to the oral organs, constituting the first section *Lophyropoda*, or to the legs, composing the second section *Branchiopoda*. Each of these is still further divided (as in the general Table) into two orders.

1. *Lophyropoda*.

(a) *Ostracoda*.

Body completely enclosed in a bivalve carapace or shell.  
Legs, 2 or 3 pairs.

	Families.	Illustrative Genera.
A single eye.	{ Cypridæ (Legs, 2 pairs).	{ Both pairs of antennæ with a tuft of hairs ... (1.) CYPRIS.
		{ Inferior antennæ without the tuft ..... (2.) CANDONA.
	{ Cytheridæ (Legs, 3 pairs).	{ Superior antennæ without the tuft ..... (3.) CYTHERE.

*Habitat* :—In ponds and lakes.

(b) *Copepoda*.

Shell jointed, forming a buckler enclosing the head and thorax. Legs, 5 pairs.

	Families.	Illustrative Genera.
A single eye.	{ Both superior antennæ in the male with a swollen joint...	{ Large and branched; ovaries 2 ..... (1.) CYCLOPS.
		{ Small and simple; ovary 1 ..... (2.) CANTHOCAMPTUS.
	{ Male with a swollen hinge on right superior antenna only ...	{ Foot-jaws, 2 pairs... Ovary 1 ..... (3.) DIAPTOMUS.

*Habitat* :—In ponds and ditches.

2. *Branchiopoda*.(a) *Phyllopoda*.

Legs from 11 to 60 pairs; joints foliaceous, branchiform.

	Families.	Illustrative Genera.
Body {	Naked ... <i>Branchiopoda</i>	{ Tail simply bifid ..... ARTEMIA.
	In a shell <i>Aspidephora</i> ...	{ Tail in two distinct pieces (1.) BRANCHIPUS. (2.) APUS.

*Habitat* :—Respectively in saltpans, ditches, and pools.

(b) *Cladocera*.

Body included in a pseudo-bivalve carapace. Legs, 5 or 6 pairs.

	Families.	Illustrative Genera.
A single eye. {	Intestine simple, no black spot in front of the eye ... } <i>Daphniidæ</i>	{ Legs, 6 pairs { (7.) DAPHNELLA ..... 2 & 2 jointed (8.) SIDA ..... 3 & 2 jointed
		{ Legs, 5 pairs { (5.) DAPHNIA ..... } 4 & 3 jointed (6.) BOSMINA ..... }
A single eye. {	Intestine convoluted, a black spot in front of the eye ... } <i>Lynceidæ</i>	{ (1.) CHYDORUS ..... } (2.) CAMPTOCERCUS . (3.) ALONA ..... } 3 & 3 jointed (4.) PLEUROXUS .....

Branches of the inferior antennæ.

*Habitat* :—In ponds, ditches, tanks, and reservoirs; usually in good water.

B. *Malacostraca*. (PLATE XX.)a. *Edriophthalmata*.(a) *Isopoda*.

(1) *Asellus aquaticus* appears to be the only fresh-water Isopod. Its distinguishing features are the following :—Superior antennæ, at least as long as the peduncle of the inferior ones. The seven pairs of legs of the order, with the terminal hooks entire; and two bifid needle-like processes at the posterior extremity of the body.



*Habitat* :—Plentiful in stagnant pools, passing the winter in the mud, from whence it emerges in the spring.

(b) *Amphipoda*.

(1) *Gammarus* is the only genus of *Amphipoda* occurring in fresh water. A short branch arises from the tip of the third joint of the superior antennæ, and the four anterior legs are in the form of small claws with the moveable tip folding on the inner side.

(2) *Gammarus pulex* is the type of the genus, and abundant in fresh-water brooks where there is an accumulation of vegetable débris.

*G. fluviatilis*, another fresh-water species, is at once distinguished by the presence of a dorsal spine at the posterior border of each abdominal segment.

*Note*.—In concluding the notice of the Crustacea it must be mentioned that the larvæ of some of the *Oniscidæ* or woodlice are aquatic.

2. *Arachnida*. (PLATE XX.)

(a) *Tardigrada*.

The water bears are distinguished by having the head marked off from the thorax, while the thorax and the abdomen are confluent. The body is faintly divided into four segments, carrying each a pair of obscurely three-jointed legs, with three or four claws at their extremity. They form but one family, including three genera as under :—

		<i>Illustrative Genera.</i>
Head	{ With appendages ... { Mouth conical, without sucker or appendages .....	(1.) EMYDIUM.
	{ Mouth sucker-like, with palpiform appendages .....	(2.) MILNESIUM.
	{ Without appendages { Mouth sucker-like, without appendages .....	(3.) MACROBIOTUS.

*Habitat* :—Stagnant water amongst water plants, in wet moss, and even in the gutters of houses, from whence they may be washed into cisterns and waterbutts.

(b) *Acarina*.

In this Order we find the *Hydrachnea* or water mites, with the head, thorax, and abdomen all fused together; the Palpi with the last joint unguiculate or spinous; the eyes two or four, and the legs generally eiliated and natatory, the posterior pair the longest. Of the several genera *Hydrachna* would appear to be the most commonly met with. (1) *Hydrachna globula* is subovate in form, of a rich deep red colour, with two pairs of eyes at a moderate distance apart, and the skin is covered with minute puneta. The generic name *Achlysia* has been given to the hexapod (six-legged) young of this genus, the Nymphs of which are parasitic on aquatic insects. (2) *Hydrachna geographica*. (3) A still more globular form. (4) *Limnochares holosericus*, crawling, not natatory.

*Habitat* :—In ponds and permanent lodgments of water. *H. globula* uses its legs with great activity, as though running through the water, instead of swimming.

3. *Insecta*.

The more usual aquatic larvæ are of the following Orders, as given by Kirby and Spence, and are sufficiently numerous to suggest that they would be more readily determined by the use of figures than by description, however elaborate.

<i>Families.</i>	<i>Genera.</i>
(a) <i>Coleoptera</i>	{ DYTISCUS, HYDROPHILUS, GYRINUS, LIMNIUS, PAR- NUS, HETEROCERCUS, ELOPHORUS, HYDRÆNA.
(b) <i>Hemiptera</i>	{ GERRIS, VELIA, HYDROMETRA, NOTONECTA, SIGARA, NEPA, RANATRA, NAUCORIS.
(c) <i>Lepidoptera</i>	A few (as NYMPHULA).
(d) <i>Trichoptera</i>	The majority (PHRYGANEÆ, &c.)
(e) <i>Neuroptera</i>	LIBELLULA, ÆSHNA, AGRION, SIALIS, EPHEMERA.
(f) <i>Diptera</i> ..	CULEX and TIPULARIÆ.
(g) <i>Aptera</i> .....	ATAX and some PODURÆ.



The smaller species of water beetles, *Hydrophilus*, *Elophorus*, *Hydræna*, *Parnus*, *Limnius*, and also *Nepa*, walk upon the water. The swimmers generally have the posterior legs fitted for the purpose. Thus, in *Dytiscus* and *Notonecta* they are furnished with a dense fringe of hairs on the shank and foot, and in *Gyrinus* the terminal joints are very much dilated.

Some insects walk and swim upon the surface without diving, as *Gerris lacustris*, the water-bug, which can walk, run, jump, or swim upon the surface.

*Hydrometra stagnorum*, very slender in form with prominent hemispherical eyes, apparently in the middle of the body, though really on the head, ramble over stagnant water, and *Velia rivulorum* courses rapidly over running streams and rivers.

## V. MOLLUSCA.

### A. *Molluscoida*.

The *Limniades* or fresh-water Polyzoa are thus characterized. *Polyzoarium* fleshy, spongy, or coriaceous; apertures angular or round, closing when the zooids recede. Tentacula ciliated in a single series, fringing a more or less crescentic lophophore (*Phylactolæmata*), or an orbicular one (*Gymnolæmata*), in both cases including the mouth. The genera *Cristatella* and *Plumatella* are examples of the former group, while *Paludicella* and *Urnatella* represent the latter.

The *Polyzoarium* in the *Cristatellidæ* is membranous, sacciform and free, or floating, while that of the *Plumatellidæ* is fixed, fistular, and confervoid.

*Habitat* :—Ponds and lakes.

### B. *Mollusca* (proper).

The simple recognition of the shell, univalve or bivalve, will suffice for the *Mollusca* proper, or the fresh-water shell-

fish, so called ; conchological works may be consulted if necessary. The following genera occurring either in this or other countries are merely cited as examples.

1. *Lamellibranchiata* (Bivalves).

(a) *Asiphonida*, *Anodon*, *Unio*, (b) *Siphonida*, *Cyclas*, *Pisidium*,  
*Cyrena*.

2. *Gasteropoda* (Univalves).

(a) *Prosobranchiata* (Operculate).

*Neritina*, *Navicella*, *Paludina*, *Ampullaria*, *Hydrobia*, *Valvata*,  
*Melania*.

(b) *Pulmonifera* (Inoperculate).

*Limnæa*, *Physa*, *Planorbis*, *Ancylus*.

# INDEX.

- A** *BRANCHIATA*, 36  
*Acanthocystis*, 38  
     habitat of, 38  
*Acarina*, 37, 54  
     habitat, 54  
*Achlya*, 8  
     supposed to be a form of *Botrytis Bassiana*, 27  
     sexual system of, as in *Vaucheria*, 27  
     prolifera, characters of, 27  
*Achlysia*, 54  
*Achnantheæ*, 22  
*Achnanthes*, 22  
*Achnanthidium*, 22  
*Acineria*, 43  
*Acomia*, 43  
*Actinophrys*, 38, 36  
     digitata, habitat, 38  
     discus, habitat, 38  
     Eichornii, habitat, 38  
     Sol, habitat, 38  
*Æshna*, 54  
*Agrion*, 54  
*Albertia*, 48  
*Alona*, 52  
*Alyscum*, 41, 43  
*Amblyophis*, 42  
*Amœba*, 10, 36, 39  
     diffusus, habitat, 39  
     radiosa, habitat, 39  
*Amœbæ*, 10  
     of minute size, 3  
*Amœboids of Volvox*, 10  
*Amphileptus*, habitat, 41  
*Amphimonas*, 42  
*Amphipoda*, 37, 53  
*Amphitrema*, 39  
     habitat, 39  
*Amphora*, 22  
*Ampullaria*, 56  
*Anartropoda*, 35, 36, 49  
*Ancylus*, 56  
*Anguillula*, 36  
     found in bilge water, 47  
     aceti, 47  
     fluvialis, 47  
     tritici, 47  
     glutinis, 47  
*Anguillulæ*, confounded with *Enoplidæ*, 47  
*Anguillulidæ*, species of, 47  
*Anisonema*, 40, 43  
*Ankistrodesmiæ*, 20  
*Ankistrodesmus*, 20  
*Annelida*, 7, 35, 36, 49  
*Annular ducts*, 7  
*ANNULOIDA*, 36, 47  
     definition of, 35  
*ANNULOSA*, 36, 37, 40  
     definition of, 35  
     Annulose animals, 7  
*Anodon*, 56  
*Antheridia of Chara*, 31  
*Anthophysa*, 42  
*Apiocystaceæ*, 12  
     characters, 25  
     grouped with *Palmellaceæ* for convenience, 25  
     classification of, 26  
*Apiocystis*, 26  
*Aptera*, 37, 54  
*Aptogonum*, 20  
*Apus*, 52  
*Aquatic Algæ*, 11  
     systematic arrangement of, 11  
*Arachnida*, 35, 37, 53  
*Arcella*, 10, 39  
     aculeata, habitat, 39  
     dentata, habitat, 39  
     vulgaris, habitat, 39  
*Artemia*, 52  
*Arthrodesmus*, 20  
*Arthropoda*, 35, 51, 37

Asellus, 37  
 „ aquaticus, characters of, 52  
 „ „ habitat, 53  
*Asiphonida*, 37  
 „ (bivalves), 56  
*Aspidephora*, 52  
*Astrionella*, 22  
*Atax*, 37

**BACILLUS**, species of, 13  
 Bacteria, 6  
 „ classification of, 13  
 „ movements of, 14  
 „ and the putrefactive process, 15, 33  
 „ of Cohn, 12, 13, 15  
*Bacteriaceæ*, 2, 12  
 „ affinity of, to the Oscillatori-ans, 2  
 „ alliance of *Parmellaceæ* with, 2  
 „ (Bacteria of Cohn), 11  
 „ in relation to *Lyngbya*, 17  
 Bacteriform bodies in gelatinous fronds, 2  
 Bacterium, species of, 13  
 „ termo, 16  
 „ „ Zooglœa form, 14  
 „ „ minuteness of re-productive particles of, compared with those of *Lyngbya*, 17  
*Batrachospermaceæ*, 12  
 „ characters of, 31  
 „ habitat of, 34  
*Batrachospermum*, 31  
*Bdellia*, 49  
 Bivalves (*Lamellibranchiata*), 56  
 Bog moss (*Sphagnum*), 7  
*Bosmina*, 52  
*Brachionæa*, 43  
*Brachionus*, 43  
 „ amphicerus, 49  
*Branchiopoda*, 51, 52  
 „ classification of, 52  
*Branchipus*, 37, 52  
*Bulbochaete*, branched filaments of, 30  
 „ setigera, 30  
*Bursaria*, 41, 44  
*Bursarina*, 41  
 „ classification of, 44  
 „ habitat of some, 42  
**CALCIUM** Carbonate, 4  
*Camptocercus*, 52  
*Campylodiscus*, 22

*Candona*, 51  
*Canthocamptus*, 51  
 Carbon, source of, in Aquatic Plants, 3  
*Carchesium*, 45  
 Carpenter, Dr., F.R.S., Orders of Rhi-zopoda adopted by him, 38  
 Cell-sap, 6  
*Ceratophyllum*, 39  
*Cercomonas*, 42  
*Chætogaster*, 50  
*Chætoglena*, 43  
*Chættonotus*, 45  
 „ larus, 43  
*Chætophora*, 30  
*Chætophoraceæ*, 12  
 „ characters of, 30  
 „ Zoospores of, 30  
 „ habitat of, 33  
*Chætotylpha*, 43  
 Chalk water, 4  
*Chara*, Antherozoids of, 31  
 „ stem of, 31  
*Characeæ*, 12  
 „ characters of, 31  
*Chilodon*, 44  
*Chilomonas*, 42  
*Chlorococcum*, distributed by rains, 32  
*Chlorogonium*, 42  
 Chromogenous Bacteria, 13  
*Chydorus*, 52  
*Chytridium*, 26  
 „ parasitic and colourless, 27  
*Ciliata*, 36, 40  
 „ defined and classified, 41  
 „ classification of, 41  
 „ their import in waters, 41  
*Cladocera*, 37  
 „ definition and arrange-ment, 52  
*Cladophora*, 28  
 „ species of, 28  
 „ glomerata, habitat of, 29  
 „ crispata, habitat of, 29  
*Clathrulina*, 38  
 „ habitat, 38  
 Clay, 5  
*Closteriæ*, 20  
*Closterium*, 20  
*Coccochloris*, 19  
 „ distribution of, by rains, 32  
 „ probably mistaken for the gonidia of Lichens, 19, 32  
*Cocconeidæ*, 22  
*Cocconeis*, 22  
*Cocconema*, 22

Codium amphibiorum, 33  
 Cœlastrum, 24  
 CœLENTERATA, 36, 45  
     " definition of, 35  
     " occurring in fresh  
         waters, 45  
 "CÆNOSARC," 46  
 Cohn's, Dr., Classification of Bacte-  
     ria, 13  
         Researches, 15  
 Colacium, 42  
 Coleoptera, 37, 54  
 Colcochæte, 30  
 Coleps, 45  
 Colletonema, 22  
 Colpoda, 44  
 Conferva, 28  
     " simple filaments of, 28  
     " Bombycina, habitat of, 29  
     " floccosa, habitat of, 29  
 Confervaceæ, characters of, 28  
     " segmentation of, 16  
     " genera of, 28  
     " habitat of, 33  
 Confervæ, 16  
     " confounded with Lyngbya  
         muralis, 17  
 Coniferæ, 7  
 Copepoda, 37  
     " definition and arrangement,  
         51  
     " habitat of, 51  
 Cordylophora, 36, 45  
     " characters of, 46  
     " lacustris, 46  
     " rivularis, 46  
 Corynida, 36, 45  
     " characters of, 46  
 Cosmarieæ, 20  
 Cosmarium, 20  
 Cotton, 7  
 Cristatella, 37  
 Cristatellidæ, 55  
 Crumenula, 43  
 Crustacea, 35, 37, 51  
 Cryptomonas, 43  
 Crystalline forms, 5  
 Culex, 37  
 Cyclas, 37, 56  
 Cyclidium, 40, 42  
 Cyclopidæ, 51  
 Cyclops, 37, 51  
 Cyclotella, 22  
 Cymbella, 22  
 Cymbellææ, 22

Cyphidium, 39  
     " arcolum, habitat, 39  
 Cypridæ, 51  
 Cypris, 37, 51  
 Cyrcna, 56  
 Cythere, 51  
 Cytheridæ, 51  
  
**D**APHNELLA, 52  
     Daphnia, 37, 52  
 Daphnidæ, 52  
 Dead, or decaying organic matter, 6  
     " Vegetable matter, 6  
     " Animal matter, 7  
 Denticula, 22  
 Derostomum, 47  
 Desmidiaceæ, 3, 11  
     " characters of, 19  
     " classification of, 20  
     " aquatic, 32  
 Desmidiææ, 20  
 Desmidium, 20  
 Desmobacteria, 13  
 Dialytic currents, 10  
 Diaptomidæ, 51  
 Diaptomus, 51  
 Diatom, 10  
 Diatoma, 22  
 Diatomaceæ, 3, 11  
     " movements of, 14  
     " characters of, 20  
     " genera of, 21  
     " classification of, 22  
     " marine and aquatic, 32  
     " distribution of, 33  
 Didymocladon, 20  
 Didymohelix, 3  
 Diffugia, 10, 39  
     " oblonga, habitat, 39  
     " proteiformis, habitat, 39  
 Dileptus, 43  
 Dinobryina, 40  
     " classification of, 42  
 Dinobryon, 42  
 Diptera, 37, 54  
 Discoidal tissue of Pine, 7  
 Discoloration of water, causes of, 3  
 Distigma, 42  
 Docidium, 20  
 Dotted and pitted tissue, 7  
 Draparnaldia, 30  
 Duckweed (Lemna), 7  
 Dujardin's appendix of symmetrical  
     *Ciliata*, 45



- Dujardin's arrangement of *Infusoria*, 40  
 „ arrangement of *Rotifera*, 48  
*Dytiscus*, 37, 54, 55
- E****DRIOPTHALMATA**, 52  
 Eggs of Entozoa, 8  
*Elophorus*, 54, 55  
*Emydium*, 53  
*Enchelia*, 41  
 „ habitat, 41  
 „ classification of, 43  
*Enchelys*, 41, 43  
*Encyonema*, 22  
*Endochrome*, 6  
 „ cleavage, in *Oscillatorieæ*, 16  
 „ „ in *Confervaceæ*, 16  
*Enoplidæ*, parasitic Nematodes, 47  
*Enteromorpha intestinalis*, 25  
*Entomostraca*, 7, 37  
 „ with parasitic *Vorticellina*, 41  
 „ description of, 51  
*Epipyxis*, 40, 41, 42, 45  
*Epithelial scales*, 8  
*Epithelium* from the cutaneous surface, 8  
 „ from the mouth, 8  
*Epithemia*, 22  
*Euastrum*, 20  
*Euchlanidota*, 49  
*Euglena*, 10, 40, 42  
 „ *viridis*, habitat, 41  
*Euglenia*, 40  
 „ classification of, 42  
*Euglypha*, 10, 39  
 „ *tuberculata*, habitat, 39  
*Eunotia*, 22  
*Eunotiæ*, 22  
*Euplota* (Ehr.), 41  
 „ classification of, 43  
*Euplotes*, 41, 44
- F****EATHER**, 8  
 Fibres of fabrics, 7  
 „ of silk, 8  
 „ of wool, 8  
*Filamentous Algæ*, minute, 3, 14  
 Fission in *Coccochloris* compared with the *Desmidiaceæ* and *Diatomaceæ*, 19  
 „ in *Palmellaceæ*, 19  
*Flagellata*, 9, 36, 40  
*Flagellata* defined, 40  
 „ classification of, 40  
*Floscularia*, 48  
 „ *ornata*, 49  
*Fragilaria*, 22  
*Fragilarieæ*, 22  
*Freshwater Algæ*, 11  
 „ distribution of, 32  
 „ notes on the habitat of, 32  
 „ *Polypes*, 35  
 „ *Polyzoa*, habitat, 55  
*Frustule* of *Desmidiaceæ* and *Diatomaceæ* compared, 21  
*Frustulia*, 22  
*Fungus-life* associated with simple decay, 15  
*Furcularia*, 48
- G****AMMARUS**, 37  
 „ characters of, 53  
 „ *fluviatilis*, 53  
 „ *pulex*, 53  
*Gasteropoda* (univalves), 37, 56  
*Gastrochæta*, 43  
 Gelatinous frond of *Volvocaceæ*, 9  
 Germ cells of *Chara*, 31  
*Gerris*, 54  
 „ *lacustris*, 55  
*Gomphonema*, 22  
*Gomphonemæ*, 22  
*Goniometry*, 5  
*Gonium*, 23  
 „ union of the cells of, 24  
 „ and *Volvox*, union of the cells, sequential to cleavage, 24  
 „ *Gonoblastidia*, 46  
 „ *Gonophores*, 46  
*Glaucoma*, 44  
*Glenodinium*, 40, 43  
*Globules* of *Chara*, 31, 32  
*Glossiphonia*, 36, 49  
*Gregarina*, 10  
*Gromia*, 36, 39  
 „ *fluviatilis*, habitat, 39  
 „ *hyalina*, habitat, 39  
*Gymnolæmata*, 55  
*Gyrinus*, 54, 55  
*Gyrosigma*, 22
- H****ABITS** of Aquatic Insects, 55  
 Hair of Rabbit, 8  
*Halteria*, 41, 43  
 Haziness, detection of, 4  
*Hemiptera*, 37, 54

Hemp, 7  
Heteramita, 42  
Heterocercus, 54  
Hexamita, 42  
Hicks, Dr. B., F.R.S., researches of, 10  
    on the Diamor-  
    phosis of *Lyngbya muralis*, 17  
Himantidium, 22  
Himantophorus, 41, 43  
*Hippocrepia*, 37  
*Hirudinea*, 36  
    " characters of, 49  
    " classification of, 49  
    " habitat, 49  
*Hirudo*, 49  
Holophyra, 44  
*Holotrocha*, 49  
Hormospora, 19  
Human hair, 8  
Hyalotheca, 20  
Hydatina Senta, 49  
*Hydatinæa*, 49  
*Hydræna*, 54, 55  
*Hydrachna*, a genus of Water-mites,  
    37, 54  
    " *geographica*, 54  
    " *globula*, 54  
*Hydrachnea*, water-mites, 54  
    " movements of *H. globula*,  
    54  
*Hydra*, 36, 45  
    " classification of species of, 46  
    " *attenuata*, 46  
    " *fusca*, 46  
    " *viridis*, 46  
    " *vulgaris*, 46  
    " habitat of, 46  
*Hydrida*, 36, 45  
    " characters of, 45  
Hydrobia, 56  
Hydrocytium, 26  
Hydrodictyon, 24  
    " related to *Pediastrum*,  
    25  
*Hydroida*, 36, 45  
Hydrometra, 54  
    " *stagnorum*, 55  
Hydrophilus, 54, 55  
*Hydrozoa*, 35, 36  
  
**I**CHTHYDINA, 49  
    *Ichthyidium*, 45  
    " *podura*, 49  
*Infundibulata*, 37  
*Infusoria*, 31, 34, 36

*Infusoria*, Orders of, 40  
    " first order of, 9  
    " or *flagellata*, 40  
    " arranged after Dujardin, 40  
*Insecta*, 35, 37, 54  
*Isopoda*, 37, 52  
  
**K**ERONA, 41, 43  
    " *polyporum* parasitic on  
    *Hydra*, 46  
*Keronia*, 41  
    " classification of, 43  
    " habitat, 41  
Kirby and Spence, their notice of the  
    aquatic larvæ of insects, 54  
  
**L**ACRYMARIA, 44  
    Lamarck's genus *Stylaria*, 50  
*Lamellibranchiata* (Bivalves), 37, 56  
Larvæ of aquatic insects, 7  
*Lepidoptera*, 54  
    " scales of, 8  
*Leptothrix ochrea*, 3  
*Leucophrys*, 41, 44  
Leydig, *Cilio-crustaceans* of, 48  
*Libellula*, 37, 54  
*Limnæa*, 56  
*Limniades* or Fresh-water Polyzoa, 35,  
    55  
*Limnius*, 54, 55  
*Limnochares holosericus*, 54  
Linen, 7  
Living Animals, 34  
    " Forms, 9  
    " Plants, 11  
*Lobosa*, 36, 38  
    " definition and classification of,  
    39  
*Lophyropoda*, 51  
    " classification of, 51  
*Lumbricini*, 50  
*Lynceidæ*, 52  
*Lyngbya*, 15  
    " in relation to *Bacteriaceæ*,  
    17  
    " referred to the *Oscillatorians*,  
    17  
    " in relation to *Ulvacæ*, 17  
    " *muralis* confounded with  
    *Confervæ*, 17  
*Lyngbyæ*, 15  
  
**M**ACROBIOTUS, 37, 53  
    *Malacostraca*, 37, 52  
Marl, 5



Mastogloia, 22  
 Megalotrocha flavicans, 49  
*Megalotrochæa*, 49  
 Melania, 56  
 Melicerta, 48  
 Melosira, 22  
 Melosireæ, 22  
 Meridion, 22  
 Meridionæ, 22  
 Mesocarpus, 28  
 Mesostomum, 47  
 Micrasterias, 20  
 Microbacteria, 13  
 Micrococcus, 13  
     " species of, 13  
     " resembled by segments  
       of minute filamentary species, 16  
 Microcoleus, 15  
 Microhaloa, 19  
     " frond of, 14  
 Microscopical Mineralogy, 5  
 Milnesium, 53  
 Mineral matters, 4  
 MOLLUSCA, 37, 55  
     " definition of, 35  
     " proper, 35, 37  
     " short note of, 55  
*Molluscoida*, 35, 37, 55  
*Monadina*, 40  
     " habitat, 41  
     " classification of, 42  
 Monas, 40, 42  
 Monormia, 18  
 Monostyla quadridentata, 49  
*Monotrocha*, 49  
 Movement, spontaneous, 10  
     " kinds of, exhibited by Pro-  
       tophyta and Protozoa, 10  
  
**N** *NAIDIDÆ*, 50  
     " speck-like eyes of, 50  
     " how known from the  
       larvæ of insects, 50  
 Nais, 36, 50  
 Nassula, 44  
 Naucoris, 54  
 Navicella, 56  
 Navicula, 22  
 Naviculæ, 22  
*Nematelmia*, 36  
*Nematoda*, 35, 36  
     " characters of, 47  
*Nematodes*, minute parasitic, 47  
*Nemertida*, 47  
 Nepa, 54

Nephelis, 49  
 Nerita, 56  
*Neuroptera*, 37, 54  
 Nymphula, 54  
 Nitella, stem of, 31  
 Nitzschia, 22  
 Nostoc, 18  
     " verrucosum, Thuret on, 18  
 Nostochacæ, 11  
     " characters of, 17  
     " classification of, 18  
     " reproduction of, 18  
 Notonecta, 37, 54, 55  
 Nucules of Chara, 31, 32  
  
**O** *ONTIDIUM*, 22  
     *Æcistes crystallinus*, 49  
*Edogoniaceæ*, 12  
     " characters of, 29  
*Edogonium*, simple filament of, 30  
     " habitat of, 30  
 Oken's genus Proto, 50  
*Oligochæta*, 36  
     " or *Setigera*, character of, 50  
     " habitat of, 50  
 Oniscidæ, aquatic larvæ of, 53  
 Opercularia, 45  
 Ophiocytium, 26  
 Ophryidium, 44  
 Ophryoglæna, 44  
 Oscillatoria, 15  
 Oscillatoriaceæ, 3, 11  
     " characters of, 15  
     " classification of, 15  
     " allied to Nostochacæ,  
       16  
     " ubiquitous, 33  
 Oscillatoriæ, 15  
     " size of, 16  
     " minute segments of,  
       resembling Micrococcus, 16  
 Oscillatorians, 6, 14  
     " altitudinal range of, 33  
*Ostracoda*, 37  
     " definition and arrange-  
       ment, 51  
     " habitat, 51  
 Ova of Entozoa, 8  
 Oxytricha, 43  
  
**P** *PALMELLA*, 19  
     " frond of, 14  
 Palmellacæ, 11  
     " characters of, 18  
     " classification of, 19

Palmellaceæ, limits of, 19  
 " fission in, 19  
 " some referable to Volvocaceæ, 19  
 " distribution of, by rains, 32  
 Paludicella, 37, 55  
 Paludina, 37, 56  
 Pandorina, 23  
 Panophrys, 44  
 Paramecia, 41  
 " habitat, 41  
 " classification of, 44  
 Paramecium, 10, 36, 41, 44  
 Parnus, 54, 55  
 Particles of Chalk, 5  
 Pathogenous Bacteria, 13  
 Pediatræ, 12  
 " classification of, 24  
 Pediatræ, relationship of, to Desmidiaceæ, 24  
 " and Hydrodictyon associated provisionally, 24  
 Pediatrum, 24  
 Pelecida, 43  
 Penium, 20  
 Peranema, 36, 40, 42  
 Peridinæ, 40  
 " habitat, 41  
 " classification of, 43  
 Peridinium, 10, 40, 43  
 Peroxide of iron, 3  
 Phacus, 40, 43  
 " habitat, 41  
 Philodinæ, 49  
 Phryganea, 37, 54  
 Phylactolæmata, 55  
 Phyllopoda, 37  
 " definition and arrangement, 50  
 " habitat, 52  
 Physa, 56  
 Pinnularia, 22  
 Pisidium, 56  
 Planaria, 36, 47  
 Planarida, 47  
 " classification of, 47  
 " habitat, 47  
 Planariola, 45  
 Planorbis, 37, 56  
 Platyelmia, 36  
 Pleurocarpus, 28  
 Pleuronema, 41  
 Pleurophrys, 39  
 " habitat, 39  
 Plumatella, 55

Plumatellida, 55  
 Pleuroxus, 52  
 "Polypary," 46  
 Polyselmis, 42  
 Polytrocha, 49  
 Polyzoa, 37  
 " fresh-water, habitat, 55  
 Polyzoarium of the Limniades, 55  
 Pond-weed (Potamogeton), 7  
 Primordial utricle, 6  
 " in Confervaceæ, 16  
 " Oscillatoricæ, 16  
 Prorodon, 44  
 Prosobranchiata, 37, 56  
 Prostomum, 47  
 Protococcus, 23  
 " life history of, 23  
 " compared with Volvox, 23  
 " Volvox compared with  
 " Pediatrum and Hydrodictyon, 23  
 " incomplete cleavage of, 24  
 Protophyta, 9, 10  
 Protozoa, 9, 36, 38  
 " definition of, 34  
 Protozoon, 9  
 Pseudopodia, 10, 38  
 Pulmonifera, 37, 56  
 Pythium, 26  
 " parasitic and colourless, 27  
  
**RADIOLARIA**, 36, 38  
 " defined and classified, 38  
 Ranatra, 54  
 Reticularia, 36, 38  
 " defined, 38  
 " classified, 39  
 Rhizopoda, 34, 36, 38  
 " excluded from Infusoria, 40  
 Rhizoclonium, 28  
 " species of, 28  
 " rivulare, habitat of, 29  
 Rhynchonema, 28  
 Rivularia, 15  
 Rivulariæ, 15  
 Rotifer, 36, 48  
 " vulgaris, 49  
 Rotifera, 3, 35, 36  
 " resemble Entomostraca, 48  
 " characters of, 48  
 " Ehrenberg's classification of, 48, 49

**S**AND, 4

Scales of Lepidoptera, 8

Scenedesmus, 20

*Schizotrocha*, 49

Sciadium, 26

*Scolecida*, 35, 36, 47

Scytonema, 15

Scytonemcæ, 15

Sediments, mode of collecting, 1

,,      microscopical examination  
          of, 2,,      high powers, and immer-  
          sion-lenses desirable for exami-  
          nation of, 2, 3

Segmentation in Confervacæ, 16

Setæ and ventral uncini of Naididæ,  
50*Setigera*, or *Oligochæta*, characters of,  
50

Sida, 52

Sigara, 54

Silicious particles, 4

Silk, 8

*Siphonida*, 37, 56

Siphonacæ, 12

,,      characters of, 26  
,,      habitat of, 33*Sorotrocha*, 49

Spectrum analysis, 5

Sphærobacteria, 13

Sphærozozma, 20

Sphinctocystis, 22

Spiral vessels and fibres, 7

Spirillum, 10

,,      species of, 13]

Spirobacteria, 13

Spirochæta, species of, 13

Spirogyra, 28

Spirostomum, 44

Spirotænia, 20

Sponges, 38

*Spongida*, 36, 39

Spongilla, 36, 38

,,      description of, 39  
,,      spicules of, 40

Staurostrum, 20

Staurocarpus, 28

Stauroneis, 22

Stentor, 41, 44

Stoneworts (*Chara* and *Nitella*), 7, 34

Striatellæ, 22

Striped muscular fibre, 8

Stylonychia, 43

Surirella, 22

Surirellæ, 22

*Suctorina*, 40,,      but phases of *Vorticellina*, 40

Symmetrical forms of Infusoria, 45

Synedra, 22

**T**ABLE of Classification of Animal  
forms, 26

Tabellaria, 22

*Tardigrada*, 37

,,      character of, 53

,,      classification of, 53

,,      habitat of, 53

Tartrate of Ammonia, the  $\bar{T}$  of, 15

Terpsinoc, 22

Tetmemorus, 20

Tetracyclus, 22

Tetraspora, 23

*Thecamonadina*, 40

,,      classification of, 43

Thorea, 31

Thuret on *Nostoc verrucosum*, 18*Trachearia*, 37

Trachelius, 41, 43

Trachelocera, 44

Trachelomonas, 43

Trepomonas, 42

Trichoda, 41, 43

*Trichodina*, 41

,,      classification of, 43

*Trichoptera*, 37, 54

Trichormus, 18

Trinema, 39

,,      acinus, habitat, 39

Tubifex, 50

*Turbellaria*, 35, 36

,,      characters of, 47

Turbidity, 4

,,      causes of, 3

Tylenchus (or so called *Vibrio*)  
tritici, 47**U**LVACEÆ, 12,,      in relation to *Lyngbya*,  
17

,,      characters of, 25

Unger, Zoospores of *Vaucheria* ob-  
served by him, 26

Unicellular plants, 18

Unio, 37, 56

Univalves (*Gasteropoda*), 56

Urceolaria, 41, 44

,,      pediculus, parasitic on  
Hydra, 46,,      pediculus on *Planaria*, 42*Urceolarina*, 41

*Urceolarina*, classification of, 44  
*Urnatella*, 55  
*Urocentrum*, 44  
*Urostyla*, 43  
*Uvella*, 42

**V**ALVATA, 56  
     Vascular plants, 7  
*Vaucheria*, species of, 26  
     " and *Achlya*, 26  
     " Zoospores of, 26  
     " sexual reproduction of, 27  
     " spores of, 10  
 Vegetable products, 7  
*Velia*, 54  
     " *rivulorum*, 55  
*Vibrio*, 10  
     " species of, 13  
 Vinegar eel, 47  
*Volvocaceæ*, 9, 12  
     " some confounded with  
         *Palmellaceæ*, 19  
     " classification of, 23  
*Volvox*, 23  
     " amœboids of, 10  
     " sphere, nature of, 23  
     " related to *Gonium* and *Pro-*  
         *tococcus*, 25  
*Vorticella*, 41, 45

*Vorticellina*, 41  
     " classification of, 45  
     " habitat, 41

**W**ATER-BEARS and mites, 7  
     Water-mites, *Hydrachnea*, 54  
 Water from the blue clay, 3  
     " from bog lands, 3  
 Wool, 8

**X**ANTHIDIUM, 20

**Z**OOGLÆA form of *Bacterium*  
     *termo*, 14  
 Zoology, the realm of, 10  
 Zoospore, 9  
 Zoospores of *Vaucheria*, Unger's  
     observations, 26  
*Zoothamnium*, 45  
*Zygnema*, 28  
*Zygnemaceæ*, characters of, 27  
     " classification of, 28  
     " altitudinal ranges of, 33  
*Zygogonium*, 28  
*Zygoselmis*, 42  
*Zygotrocha*, 49  
 Zymogenous *Bacteria*, 13

LONDON :  
SAVILL, EDWARDS AND CO., PRINTERS, CHANDOS STREET,  
COVENT GARDEN.



A Manual of Practical Hygiene. By EDMUND A. PARKES, M.D., F.R.C.P., F.R.S., Professor of Hygiene in the Army Medical School. Fourth Edition, 8vo, with Plates and Woodcuts, 16s.

A Handbook of Hygiene for the Use of Sanitary Authorities and Health Officers. By GEORGE WILSON, M.D. Edin., Medical Officer of Health for North Warwickshire. Second Edition, crown 8vo, with Engravings, 8s. 6d.

The Microscope and its Revelations. By WILLIAM B. CARPENTER, M.D., F.R.S. Fifth Edition, with more than 500 Engravings. Crown 8vo, 15s.

The Principles and Practice of Medical Jurisprudence. By ALFRED S. TAYLOR, M.D., F.R.C.P., F.R.S., Professor of Medical Jurisprudence to Guy's Hospital. Second Edition, 2 vols., 8vo, with 189 Engravings, £1 11s. 6d.

*By the same Author,*

A Manual of Medical Jurisprudence. Ninth Edition, with Engravings. Crown 8vo, 14s.

*Also,*

Poisons in Relation to Medical Jurisprudence and MEDICINE. Third Edition, with 104 Engravings. Crown 8vo, 16s.

A Toxicological Chart, exhibiting at one view the Symptoms, Treatment, and Mode of Detecting the Various Poisons, Mineral, Vegetable, and Animal. To which are added Concise Directions for the Treatment of Suspended Animation. By WILLIAM STOWE, M.R.C.S.E. Thirteenth Edition. Sheet, 2s.; Roller, 5s.

Medicinal Plants. Being Descriptions, with Original Figures of the Principal Plants employed in Medicine, and an Account of their Properties and Uses. By ROBERT BENTLEY, F.L.S., Professor of Botany in King's College, London, and Professor of Botany and Materia Medica to the Pharmaceutical Society of Great Britain; and HENRY TRIMEN, M.B., F.L.S., British Museum, and Lecturer on Botany at St. Mary's Hospital Medical School. To consist of about 36 Monthly Parts, each containing Eight Coloured Plates, 5s.

A Manual of Botany: including the Structure, Functions, Classifications, Properties, and Uses of Plants. By ROBERT BENTLEY, F.L.S., Professor of Botany, King's College, and to the Pharmaceutical Society. Third Edition, with 1133 Engravings. Crown 8vo, 14s.

Lectures on Nursing. By WILLIAM ROBERT SMITH, Resident Surgeon, Hants County Hospital. With 27 Engravings, crown 8vo, 6s.

---

J. & A. CHURCHILL, NEW BURLINGTON STREET.

Cooley's Cyclopædia of Practical Receipts, Processes, and  
COLLATERAL INFORMATION IN THE ARTS, MANUFACTURES,  
PROFESSIONS, AND TRADES: Including Pharmacy and Domestic  
Economy and Hygiene. Designed as a Comprehensive Supplement to the  
Pharmacopœias and General Book of Reference for the Manufacturer, Trades-  
man, Amateur, and Heads of Families. Fifth Edition, Revised and partly  
Rewritten by Professor RICHARD V. TUSON, F.C.S., assisted by several  
Scientific Contributors. 8vo, 28s.

Advice to a Mother on the Management of her Children.  
By PYE H. CHAVASSE, F.R.C.S. Twelfth Edition, fcap. 8vo, 2s. 6d.

*By the same Author,*

Counsel to a Mother on the Care and Rearing of her  
Children, being the Companion Volume of "Advice to a Mother." Third  
Edition, fcap. 8vo, 2s. 6d.

*Also,*

Advice to a Wife on the Management of her own  
Health. With an Introductory Chapter especially addressed to a Young Wife.  
Eleventh Edition, fcap. 8vo, 2s. 6d.

The Medical Remembrancer; or, Book of Emergencies.  
Fifth Edition. By JONATHAN HUTCHINSON, F.R.C.S., Senior Surgeon to the  
London Hospital. 32mo, 2s. 6d.

A Manual of Elementary Chemistry, Theoretical and  
Practical. By G. FOWNES, F.R.S. Edited by HENRY WATTS, B.A., F.R.S.  
Eleventh Edition. With 163 Engravings. Crown 8vo, 15s.

Chemistry, Inorganic and Organic: With Experiments.  
By CHARLES L. BLOXAM, Professor of Chemistry in King's College, London.  
Third Edition. With 295 Engravings. 8vo, 16s.

*By the same Author,*

Laboratory Teaching: or, Progressive Exercises in  
Practical Chemistry, with Analytical Tables. Third Edition. With 89 En-  
gravings. Crown 8vo, 5s. 6d.

Handbook of Chemical Technology. By RUDOLF  
WAGNER, Ph.D., Professor of Chemical Technology at the University of  
Wurzburg. Translated and Edited from the Eighth German Edition, with  
Extensive Additions, by WILLIAM CROOKES, F.R.S. With 336 Engravings.  
8vo, 25s.

---

J. & A. CHURCHILL, NEW BURLINGTON STREET.



LONDON, NEW BURLINGTON STREET,

OCTOBER, 1875.

A LIST  
OF  
MESSRS CHURCHILL'S  
WORKS  
ON  
CHEMISTRY, MATERIA MEDICA,  
PHARMACY, BOTANY,  
THE MICROSCOPE,  
AND  
OTHER BRANCHES OF SCIENCE

# I N D E X

	PAGE
Beasley's Pocket Formulary	ix
Do. Druggist's Receipt Book	ix
Do. Book of Prescriptions	ix
Bentley's Manual of Botany	xi
Bentley and Trinen's Medicinal Plants	xi
Bernays' Syllabus of Chemistry	iv
Bloxam's Chemistry	iii
Do. Laboratory Teaching	iii
Bowman's Practical Chemistry	iv
Bradley's Comparative Anatomy and Physiology	xiii
Brooke's Natural Philosophy	xv
Brown's Analytical Tables	iv
Carpenter's Microscope and its Revelations	xii
Chauveau's Comparative Anatomy	xiii
Clowes' Practical and Analytical Chemistry	iv
Cooley's Cyclopædia of Receipts	vii
Dunglison's Medical Lexicon	xiv
Fayrer's Poisonous Snakes of India	xii
Do. Royal Tiger of Bengal	xii
Fownes' Manual of Chemistry	iv
Frankland's How to Teach Chemistry	vi
Fresenius' Chemical Analysis	iv
Galloway's First Step in Chemistry	v
Do. Second do. do.	v
Do. Qualitative Analysis	v
Do. Chemical Tables	v
Greene's Tables of Zoology	xiv
Griffiths' Chemistry of the Four Seasons	v
Hardwich's Photography, by Dawson	xv
Huxley's Anatomy of Vertebrates...	xiii
Do. Classification of Animals...	xiii
Kay-Shuttleworth's Modern Chemistry	v
Kohlrausch's Physical Measurements	xi
Lescher's Elements of Pharmacy	x
Martin's Microscopic Mounting	xii
Mayne's Medical Vocabulary	xv
Microscopical Journal (Quarterly)...	xii
Nevins' Analysis of Pharmacopœia	xi
Ord's Comparative Anatomy	xiii
Pereira's Selecta e Præscriptis	ix
Pharmaceutical Journal and Transactions	xi
Phillips' Materia Medica	vi
Prescriber's Pharmacopœia	ix
Price's Photographic Manipulation	xv
Proctor's Practical Pharmacy	x
Rodwell's Natural Philosophy	xv
Royle's Materia Medica...	vii
Shea's Animal Physiology	xiv
Smith's Pharmaceutical Guide	viii
Southall's Materia Medica	viii
Squire's Companion to the Pharmacopœia	viii
Do. Hospital Pharmacopœias	viii
Steggall's First Lines for Chemists	x
Stowe's Toxicological Chart	v
Sutton's Volumetric Analysis	x
Taylor on Poisons	vii
Thorowgood's Materia Medica	xi
Tuson's Veterinary Pharmacopœia	vi
Valentin's Inorganic Chemistry	vi
Do. Qualitative Analysis	xiv
Vestiges of Creation	vi
Wagner's Chemical Technology	xiii
Wahlruch's Dictionary of Materia Medica	xiii
Whalley's Human Eye	xiv
Wilson's Zoology	x
Wittstein's Pharmaceutical Chemistry, by Darby	xi
Year Book of Pharmacy	

\* \* *The Works advertised in this Catalogue may be obtained through any Bookseller in the United Kingdom. or direct from the Publishers, on Remittance being made.*

A LIST OF

*Messrs CHURCHILL'S WORKS*

ON SCIENCE

---

*C. L. Bloxam*

CHEMISTRY, INORGANIC and ORGANIC :  
 With Experiments. By CHARLES L. BLOXAM, Professor of Chemistry in  
 King's College, London ; Professor of Chemistry in the Department for  
 Artillery Studies, Woolwich. Third Edition. With 295 Engravings.

[8vo, 16s.

\* \* It has been the author's endeavour to produce a Treatise on Chemistry sufficiently comprehensive for those studying the science as a branch of general education, and one which a student may peruse with advantage before commencing his chemical studies at one of the colleges or medical schools, where he will abandon it for the more advanced work placed in his hands by the professor. The special attention devoted to Metallurgy and some other branches of Applied Chemistry renders the work especially useful to those who are being educated for employment in manufacture.

"Professor Bloxam has given us a most excellent and useful practical treatise. His 666 pages are crowded with facts and experiments, nearly all well chosen, and many quite new, even to scientific men. . . It

is astonishing how much information he often conveys in a few paragraphs. We might quote fifty instances of this." — *Chemical News*.

*By the same Author*

LABORATORY TEACHING: Or, Progressive Exercises in  
 Practical Chemistry, with Analytical Tables. Third Edition. With 89  
 Engravings . . . . . Crown 8vo, 5s. 6d.

\* \* This work is intended for use in the chemical laboratory by those who are commencing the study of practical chemistry. It does not presuppose any knowledge of chemistry on the part of the pupil, and does not enter into any theoretical speculations. It dispenses with the use of all costly apparatus and chemicals, and is divided into separate exercises or lessons, with examples for practice, to facilitate the instruction of large classes. The method of instruction here followed has been adopted by the author, after twenty-three years' experience as a teacher in the laboratory.

*Albert J. Bernays*

NOTES FOR STUDENTS IN CHEMISTRY: Being a Syllabus of Chemistry and Practical Chemistry. By ALBERT J. BERNAYS, Professor of Chemistry at St. Thomas's Hospital. Fifth Edition.

[Fcap 8vo, 3s. 6d.]

\* \* A new feature is an Appendix giving the doses of the chief chemical preparations of the "Materia Medica."

"The new notation and nomenclature are now exclusively used. We notice additional notes in apparently every paragraph in the book, and a close revision of the whole."—*Scientific Opinion.*

—o—

*John E. Bowman and C. L. Bloxam*

PRACTICAL CHEMISTRY, Including Analysis. By JOHN E. BOWMAN and C. L. BLOXAM. Sixth Edition. With 98 Engravings . . . . . Fcap 8vo, 6s. 6d.

\* \* The intention of this work is to furnish to the beginner a text-book of the practical *minutiae* of the laboratory. The various processes employed in analysis, or which have been devised for the illustration of the principles of the science, are explained in language as simple as possible. This edition has been embellished with a large number of additional wood engravings from sketches made in the laboratory.

—o—

*J. Campbell Brown*

ANALYTICAL TABLES for STUDENTS of PRACTICAL CHEMISTRY. By J. CAMPBELL BROWN, D.Sc. Lond., F.C.S.

[8vo, 2s. 6d.]

—o—

*Frank Clowes*

PRACTICAL CHEMISTRY AND QUALITATIVE INORGANIC ANALYSIS. By FRANK CLOWES, B. Sc. Lond., F.C.S. Lond. and Berlin, Science Master at Queenwood College. With 46 Engravings . . . . . Crown 8vo, 7s. 6d.

\* \* This work is an Elementary Treatise specially adapted for use in the Laboratories of Schools and Colleges, and by beginners.

—o—

*G. Fownes*

A MANUAL OF ELEMENTARY CHEMISTRY, Theoretical and Practical. BY G. FOWNES, F.R.S. Edited by Henry Watts, B.A., F.R.S. Eleventh Edition. With 163 Engravings. Crown 8vo, 15s.

—o—

*Remigius Fresenius*

QUALITATIVE ANALYSIS. By C. REMIGIUS FRESENIUS. Edited by Arthur Vacher. Eighth Edition, with Coloured Plate of Spectra and 47 Engravings . . . . . 8vo, 12s. 6d.

*By the same Author*

QUANTITATIVE ANALYSIS. Edited by Arthur Vacher. Sixth Edition (reprinted from the Fourth), with 186 Engravings. 8vo, 18s.

*Robert Galloway*

THE FIRST STEP IN CHEMISTRY: A New Method for Teaching the Elements of the Science. By ROBERT GALLOWAY, Professor of Applied Chemistry in the Royal College of Science for Ireland. Fourth Edition, with Engravings . . . . . Fcap 8vo, 6s. 6d.

*By the same Author*

THE SECOND STEP IN CHEMISTRY: or, the Student's Guide to the Higher Branches of the Science. With Engravings. [Fcap 8vo, 10s.

*Also*

A MANUAL OF QUALITATIVE ANALYSIS. Fifth Edition, with Engravings . . . . . Post 8vo, 8s. 6d.

*Also*

CHEMICAL TABLES: On Five large Sheets, for School and Lecture Rooms. Second Edition . . . . . The Set, 4s. 6d.

"We can always give praise to Mr. Galloway's educational works. They are invariably written on a system and founded on experience, and the teaching is clear, and in general complete."—*Chemical News*.

"Mr. Galloway has done much to simplify the study of chemistry by the instructive manner in which he places the principal details of the science before his readers."—*British Medical Journal*.

—o—

*T. Griffiths*

CHEMISTRY OF THE FOUR SEASONS: Spring, Summer, Autumn, Winter. By T. GRIFFITHS. Second Edition, with Engravings. [Fcap 8vo, 7s. 6d.

—o—

*U. J. Kay-Shuttleworth*

FIRST PRINCIPLES OF MODERN CHEMISTRY.

By U. J. KAY-SHUTTLEWORTH, M.P. Second Edition. Crown 8vo, 4s. 6d.

"We can recommend the book."—*Athenæum*.

"Deserving warmest commendation."—*Popular Science Rev.*

—o—

*Francis Sutton*

HANDBOOK OF VOLUMETRIC ANALYSIS; or, the Quantitative Estimation of Chemical Substances by Measure applied to Liquids, Solids, and Gases. By FRANCIS SUTTON, F.C.S., Norwich. Third Edition. With Engravings . . . . . 8vo. *In the Press*

\* \* This work is adapted to the requirements of pure Chemical Research, Pathological Chemistry, Pharmacy, Metallurgy, Manufacturing Chemistry, Photography, etc., and for the Valuation of Substances used in Commerce, Agriculture, and the Arts.

"Mr. Sutton has rendered an essential service by the compilation of his work."—*Chemical News*.



*W. G. Valentin*

INTRODUCTION TO INORGANIC CHEMISTRY. By  
WM. G. VALENTIN, F.C.S., Principal Demonstrator of Practical Chem-  
istry in the Royal School of Mines and Science Training Schools,  
South Kensington. With 82 Engravings . . . . . 8vo, 6s. 6d.

*Also*

QUALITATIVE CHEMICAL ANALYSIS. Third Edition.  
With 19 Engravings . . . . . 8vo, 7s. 6d.

*Also*

TABLES FOR THE QUALITATIVE ANALYSIS OF  
SIMPLE AND COMPOUND SUBSTANCES, both in the Dry and Wet  
Way. On indestructible paper . . . . . 8vo, 2s. 6d.

—o—

*Edward Frankland*

HOW TO TEACH CHEMISTRY: Hints to Science  
Teachers and Students. Six Lectures delivered at the Royal College of  
Chemistry by EDWARD FRANKLAND, D.C.L., F.R.S., Summarised and  
Edited by GEORGE CHALONER, F.C.S. With 47 Engravings.  
[Crown 8vo, 3s. 6d.]

—o—

*R. Wagner and W. Crookes*

HANDBOOK OF CHEMICAL TECHNOLOGY. By  
RUDOLF WAGNER, Ph.D., Professor of Chemical Technology at the  
University of Wurtzburg. Translated and Edited from the Eighth German  
Edition, with Extensive Additions, by WILLIAM CROOKES, F.R.S. With  
336 Engravings . . . . . 8vo, 25s.

\* \* The design of this work is to show the application of the science of chemistry to  
the various manufactures and industries. The subjects are treated of in eight divisions,  
as follows:—1. Chemical Metallurgy, Alloys, and Preparations made and obtained from  
Metals. 2. Crude Materials and Products of Chemical Industry. 3. Glass, Ceramic  
Ware, Gypsum, Lime, Mortar. 4. Vegetable Fibres. 5. Animal Substances. 6. Dye-  
ing and Calico Printing. 7. Artificial Light. 8. Fuel and Heating Apparatus.

“Full and exact in its information on  
almost every point.”—*Engineer*.

“This book will permanently take its  
place among our manuals.”—*Nature*.

“Mr. Crookes deserves praise, not only  
for the excellence of his translation, but  
also for the original matter he has added.”  
—*American Journal of Science and Arts*.

—o—

*C. D. F. Phillips*

MATERIA MEDICA AND THERAPEUTICS: VEGE-  
TABLE KINGDOM. By CHARLES D. F. PHILLIPS, M.D. 8vo, 15s.

“It is the great distinction of this book that an amount of space is given in it to care-  
ful discussion of the physiological and the therapeutical actions of drugs greater than has  
been given in any previous English text-book of Materia Medica.”—*Practitioner*.



*J. Forbes Royle and John Harley*

A MANUAL OF MATERIA MEDICA. By J. FORBES ROYLE, M.D., F.R.S., and JOHN HARLEY, M.D. Sixth Edition, with numerous Engravings . . . . . Crown 8vo. *In the Press*

"This Manual is, to our minds, unrivalled | and completeness of information."—*British Medical Journal*.  
in any language for condensation, accuracy,

—o—

*J. C. Thorowgood*

THE STUDENT'S GUIDE TO MATERIA MEDICA. Including the New Additions to the British Pharmacopœia. By JOHN C. THOROWGOOD, M.D. Lond., Lecturer on Materia Medica at the Middlesex Hospital. With Engravings . . . . . Fcap 8vo, 6s. 6d.

"Students can hardly hope for a more serviceable text-book."—*Practitioner*.

—o—

*Adolphe Wahltuch*

A DICTIONARY OF MATERIA MEDICA AND THERAPEUTICS. By ADOLPHE WAHLTUCH, M.D. . . . . 8vo, 15s.

\* \* The purpose of this work is to give a tabular arrangement of all drugs specified in the British Pharmacopœia of 1867. Every table is divided into six parts:—(1) *The Name and Synonyms*; (2) *Character and Properties or Composition*; (3) *Physiological Effects and Therapeutics*; (4) *Form and Doses*; (5) *Preparations*; (6) *Prescriptions*. Other matter elucidatory of the Pharmacopœia is added to the work.

"A very handy book."—*Lancet*.

—o—

*R. V. Tuson*

COOLEY'S CYCLOPÆDIA OF PRACTICAL RECEIPTS, PROCESSES, AND COLLATERAL INFORMATION IN THE ARTS, MANUFACTURES, PROFESSIONS, AND TRADES: Including Pharmacy and Domestic Economy and Hygiène. Designed as a Comprehensive Supplement to the Pharmacopœias and General Book of Reference for the Manufacturer, Tradesman, Amateur, and Heads of Families. Fifth Edition, Revised and partly Rewritten by Professor RICHARD V. TUSON, F.C.S., assisted by several Scientific Contributors . . . . . 8vo, 28s.

"A much improved edition. . . . Long recognised as a general book of reference."—*Times*.

"The book is of considerable value for household use, as well as professional purposes, for it contains a quantity of interesting information relating to the composition

of articles in common use as food and medicine."—*Pall Mall Gazette*.

"Other of the articles, as on 'brewing,' 'bread,' etc., are specimens of what cyclopædic writing should be, being concise and thoroughly exhaustive of the practical portion of the subject."—*Veterinarian*.

*W. Southall*

THE ORGANIC MATERIA MEDICA OF THE BRITISH  
PHARMACOPŒIA SYSTEMATICALLY ARRANGED : Together  
with Brief Notices of the Remedies contained in the Indian and United  
States Pharmacopœias. By W. SOUTHALL, F.L.S. . . . Post 8vo, 2s. 6d.

—o—

*J. B. Smith*

PHARMACEUTICAL GUIDE TO THE FIRST AND  
SECOND EXAMINATIONS. By JOHN BARKER SMITH. Second  
Edition . . . . . Crown 8vo, 6s. 6d.

FIRST AND SECOND EXAMINATIONS

LATIN GRAMMAR—FRACTIONS — METRIC SYSTEM — MATERIA MEDICA — BOTANY  
—PHARMACY—CHEMISTRY—PRESCRIPTIONS.

—o—

*John Steggall*

FIRST LINES FOR CHEMISTS AND DRUGGISTS  
preparing for Examination at the Pharmaceutical Society. By JOHN  
STEGGALL, M.D. Third Edition . . . . . 18mo, 3s. 6d.

## CONTENTS

Notes on the British Pharmacopœia, the Substances arranged alphabetically.	Thermometers.
Table of Preparations, containing Opium, Antimony, Mercury, and Arsenic.	Specific Gravity.
Classification of Plants.	Weights and Measures.
	Questions on Pharmaceutical Chemistry and Materia Medica.

—o—

*Peter Squire*

COMPANION TO THE BRITISH PHARMACOPŒIA.

With Practical Hints on Prescribing ; including a Tabular Arrangement  
of Materia Medica for Students, and a Concise Account of the Principal  
Spas of Europe. By PETER SQUIRE, Chemist in Ordinary to the Queen  
and the Prince of Wales ; late President of the Pharmaceutical Society.  
Tenth Edition . . . . . 8vo, 10s. 6d.

*By the same Author*

PHARMACOPŒIAS OF THE LONDON HOSPITALS.

Third Edition. . . . . Fcap 8vo, 6s.

\* \* Mr. SQUIRE has collected all the Formulæ used in twenty-two of the principal  
Hospitals of London, and arranged them in groups of mixtures, gargles, &c., &c. These  
Formulæ were revised and approved by the medical staff of each of the Hospitals, and  
may therefore be taken as an excellent guide to the medical practitioner, both as to dose  
and best menstruum in prescribing.

*J. Birkbeck Nevins*

THE PRESCRIBER'S ANALYSIS OF THE BRITISH PHARMACOPŒIA. By J. BIRKBECK NEVINS, M.D. Lond., Lecturer on Materia Medica in the Liverpool Royal Infirmary Medical School. Third Edition, Revised and Enlarged . . . . . Royal 32mo, 3s. 6d.

—o—

THE PRESCRIBER'S PHARMACOPŒIA : The Medicines arranged in Classes according to their Action, with their Composition and Doses. By A PRACTISING PHYSICIAN. Fifth Edition.  
[Fcap 16mo, cloth, 2s. 6d.; roan, with flap and elastic band, 3s. 6d]

—o—

*Jonathan Pereira*

SELECTA E PRÆSCRIPTIS: Containing Lists of the Terms, Phrases, Contractions, and Abbreviations used in Prescriptions, with Explanatory Notes; the Grammatical Construction of Prescriptions; Rules for the Pronunciation of Pharmaceutical Terms; a Prosodiacal Vocabulary of the Names of Drugs, &c.; and a Series of Abbreviated Prescriptions illustrating the use of the preceding terms. To which is added a Key, containing the Prescriptions in an Unabbreviated Form, with a Literal Translation for the Use of Medical and Pharmaceutical Students. By JONATHAN PEREIRA, M.D., F.R.S. Sixteenth Edition . . . . . 32mo, 5s.

—o—

*Henry Beasley*

THE POCKET FORMULARY AND SYNOPSIS OF THE BRITISH AND FOREIGN PHARMACOPŒIAS: Comprising Standard and approved Formulæ for the Preparations and Compounds employed in Medical Practice. By HENRY BEASLEY. Ninth Edition.  
[18mo, 6s.

*By the same Author*

THE DRUGGIST'S GENERAL RECEIPT-BOOK: Comprising a Copious Veterinary Formulary and Table of Veterinary Materia Medica; Patent and Proprietary Medicines, Druggists' Nostrums, &c.; Perfumery, Skin Cosmetics, Hair Cosmetics, and Teeth Cosmetics; Beverages, Dietetic Articles and Condiments; Trade Chemicals, Miscellaneous Preparations and Compounds used in the Arts, &c.; with useful Memoranda and Tables. Seventh Edition . . . . . 18mo, 6s.

*Also*

THE BOOK OF PRESCRIPTIONS: Containing 3,000 Prescriptions collected from the Practice of the most eminent Physicians and Surgeons, English and Foreign. Fourth Edition . . . . . 18mo, 6s.

"Mr. Beasley's 'Pocket Formulary,' 'Druggist's Receipt-Book,' and 'Book of Prescriptions' form a compact library of reference admirably suited for the dispensing desk."—*Chemist and Druggist*.



*Alfred S. Taylor*

POISONS IN RELATION TO MEDICAL JURISPRUDENCE AND MEDICINE. By ALFRED S. TAYLOR, M.D., F.R.S., Professor of Medical Jurisprudence to Guy's Hospital. Third Edition, with 104 Engravings . . . . . Crown 8vo, 16s.

—o—

*F. H. Lescher*

AN INTRODUCTION to the ELEMENTS of PHARMACY.

By F. HARWOOD LESCHER. Fifth Edition . . . 8vo. *In the Press.*

Sec. I. MATERIA MEDICA; II. BOTANY; III. CHEMISTRY; IV. PHARMACY; V. PRESCRIPTIONS; VI. PRACTICAL DISPENSING.

—o—

*B. S. Proctor*

LECTURES ON PRACTICAL PHARMACY.

By BARNARD S. PROCTOR, Lecturer on Pharmacy at the College of Medicine, Newcastle-on-Tyne. With 43 Engravings . . . 8vo, 12s.

## CONTENTS

Drying—Comminution—Solution—Crystallisation—Precipitation—Diffusion in Liquids, Dialysis, Osmosis, &c.—Evaporation, Boiling, Fusion, and Calcination—Distillation and Sublimation—Filtration and Percolation—Official Pharmacy—Official Liquors or Solutions—Official Infusions and Decoctions—Extracts—Spirits, Tinctures, Wines, Vinegars, Liniments—Official Products of Distillation and Sublimation—Official Products of Fusion—Official Saline Preparations, &c., Crystallised, Precipitated, Scaled, or Granulated—Complex Processes—Dispensing—Reading Autograph Prescriptions—Pills—Powders, Ointments, Plasters, Suppositories, &c.—Qualitative Tests of the Pharmacopœia—Quantitative Testing of the Pharmacopœia—Pharmacy of Special Drugs.

"A good specimen of a treatise on Chemistry as applied to a special art."—*Chemical News.*

—o—

*William Stowe*

A TOXICOLOGICAL CHART, Exhibiting at one view the Symptoms, Treatment, and Mode of Detecting the Various Poisons, Mineral, Vegetable, and Animal. To which are added concise Directions for the Treatment of Suspended Animation. By WILLIAM STOWE, M.R.C.S.E. Thirteenth Edition . . . . . Sheet, 2s.; Roller, 5s.

—o—

*G. C. Wittstein*

PRACTICAL PHARMACEUTICAL CHEMISTRY: An

Explanation of Chemical and Pharmaceutical Processes; with the Methods of Testing the Purity of the Preparations, deduced from Original Experiments. By Dr. G. C. WITTSTEIN. Translated from the Second German Edition by STEPHEN DARBY . . . . . 18mo, 6s.

"It would be impossible too strongly to recommend this work to the beginner, for the completeness of its explanations, by following which he will become well grounded in practical chemistry."—*From the Introduction by Dr. Buchner.*

THE PHARMACEUTICAL JOURNAL AND TRANSACTIONS. Published weekly . . . . . Price 4d.  
—o—

THE YEAR-BOOK OF PHARMACY: Containing the Proceedings at the Yearly Meeting of the British Pharmaceutical Conference, and a Report on the Progress of Pharmacy, which includes notices of all Pharmaceutical Papers, new Processes, Preparations, and Formulæ published throughout the world. Published annually.

[8vo, 1870, '71, '72, 7s. 6d. each ; 1873, '74, 10s. each  
—o—

*R. V. Tuson*

A PHARMACOPŒIA, INCLUDING THE OUTLINES OF MATERIA MEDICA AND THERAPEUTICS, for the Use of Practitioners and Students of Veterinary Medicine. By RICHARD V. TUSON, F.C.S., Professor of Chemistry and Materia Medica at the Royal Veterinary College. Second Edition . . . . . 7s. 6d.

“Not only practitioners and students of veterinary medicine, but chemists and druggists will find that this book supplies a want in veterinary literature.”—*Chemist and Druggist*.  
—o—

*Robert Bentley*

A MANUAL OF BOTANY: Including the Structure, Functions, Classifications, Properties, and uses of Plants. By ROBERT BENTLEY, F.L.S., Professor of Botany, King's College, and to the Pharmaceutical Society. Third Edition, with 1,138 Engravings. Crown 8vo, 14s.

“As the standard manual of botany its position is undisputed.”—*Chemist and Druggist*.  
—o—

*Robert Bentley and Henry Trimen*

MEDICINAL PLANTS: being Figures with accompanying Botanical Descriptions, and an Account of the Properties and Uses of the Principal Plants employed in Medicine. By ROBERT BENTLEY, F.L.S., Professor of Botany in King's College, and to the Pharmaceutical Society ; and HENRY TRIMEN, M.B., F.L.S., Lecturer on Botany in St. Mary's Hospital Medical School. Part I., containing 8 Plates, large 8vo, 5s. (on October 1).

\* \* A Prospectus and Specimen Plate will be sent on application.  
—o—

*F. Kohlrausch*

AN INTRODUCTION TO PHYSICAL MEASUREMENTS, With Appendices on Absolute Electrical Measurement, etc. By Dr. F. KOHLRAUSCH. Translated from the Second German Edition by T. H. WALLER, B.A., B. Sc., and H. R. PROCTER, F.C.S. With Engravings.

[8vo, 12s.

*W. B. Carpenter*

THE MICROSCOPE AND ITS REVELATIONS. By  
W. B. CARPENTER, M.D., F.R.S. Fifth Edition, with more than 500  
Engravings . . . . . Crown 8vo, 15s.

\* \* \* The author has aimed to combine within a moderate compass that information in regard to the use of his instrument and its appliances, which is most essential to the working microscopist, with such an account of the objects best fitted for his study as may qualify him to comprehend what he observes, and thus prepare him to benefit science, whilst expanding and refreshing his own mind.

— o —

*J. H. Martin*

A MANUAL OF MICROSCOPIC MOUNTING; with Notes  
on the Collection and Examination of Objects. By JOHN H. MARTIN,  
author of "Microscopic Objects." With upwards of 100 Engravings.  
[8vo, 7s. 6d.

\* \* \* The aim of this work is to supply the student with a concise manual of the principles of microscopic mounting, and to assist his progress in the manual dexterity, as far as illustrations and words render it possible, necessary in their application.

— o —

THE QUARTERLY JOURNAL OF MICROSCOPICAL  
SCIENCE. (Established in 1852.) Edited by Dr. J. F. PAYNE, Assistant-  
Physician at St. Thomas's Hospital; E. RAY LANKESTER, Professor of  
Zoology and Comparative Anatomy in University College, London; and  
W. T. THISELTON DYER, Professor of Botany to the Royal Horticultural  
Society . . . . . Annual Subscription, 16s.; Single Numbers, 4s.

\* \* \* The Memoirs are, when needful, illustrated by Lithographic Plates, many of which are Coloured. The Journal contains, in addition, Notes and Memoranda, Reviews of Books, Quarterly Chronicle, and Proceedings of Societies.

— o —

*J. Fayrer*

THE THANATOPHIDIA OF INDIA; being a Description  
of the Venomous Snakes of the Indian Peninsula. With an Account of  
the Influence of their Poison on Life, and a Series of Experiments. By  
J. FAYRER, M.D., C.S.I., Honorary Physician to the Queen; late President  
of the Asiatic Society of Bengal. Second Edition, with 31 Plates (28  
Coloured) . . . . . Folio, 7l. 7s.

*By the same Author*

THE ROYAL TIGER OF BENGAL: His Life and Death.  
With Map and Engravings . . . . . Crown 8vo, 5s.



*A. Chauveau and G. Fleming*

CHAUVEAU'S COMPARATIVE ANATOMY OF THE DOMESTICATED ANIMALS. Translated from the Second French Edition, and Edited by GEORGE FLEMING, F.R.G.S., Veterinary Surgeon, Royal Engineers; Author of "Travels on Horseback in Mantchu Tartary," "Horse-shoes and Horse-shoeing," "Animal Plagues," etc. With 450 Engravings . . . . . 8vo, £1 11s. 6d.

"Mr. Fleming has earned the gratitude of the whole of his profession by presenting to the veterinary surgeon and student, in an English dress, one of the best and most comprehensive of Continental text-books, enriched with additions which prove him to have been a conscientious student of the best writers on the Comparative Anatomy of the Mammalia. . . . We have nothing but praise to bestow on the manner in which Mr. Fleming has performed his work."—*Medico-Chirurgical Review*.

—o—

*T. H. Huxley*

A MANUAL OF THE ANATOMY OF VERTEBRATED ANIMALS. By Prof. HUXLEY, LL.D., F.R.S. With numerous Engravings. . . . . [Fcap 8vo, 12s.

*By the same Author*

INTRODUCTION to the CLASSIFICATION of ANIMALS. With Engravings . . . . . 8vo, 6s.

—o—

*S. Messenger Bradley*

MANUAL OF COMPARATIVE ANATOMY AND PHYSIOLOGY. By S. MESSENGER BRADLEY, F.R.C.S., Senior Assistant Surgeon to the Manchester Royal Infirmary. Third Edition, with 61 Engravings . . . . . Post 8vo, 6s. 6d.

—o—

*W. M. Ord*

NOTES ON COMPARATIVE ANATOMY: a Syllabus of a Course of Lectures delivered at St. Thomas's Hospital. By WILLIAM MILLER ORD, M.B. Lond., M.R.C.P., Assistant-Physician to the Hospital, and Lecturer in its Medical School . . . . . Crown 8vo, 5s.

"Compact, lucid, and well arranged. These Notes will, if well used, be valuable to learners, perhaps still more so to teachers."—*Nature*.

"We have gone through it carefully, and we are thoroughly satisfied with the manner in which the author has discharged his task."—*Pop. Science Review*.

—o—

*W. Whalley*

THE HUMAN EYE, WITH REMARKS ON THE EYES OF INFERIOR ANIMALS: A Popular Description. By W. WHALLEY, M.R.C.S. With 40 Engravings . . . . . Fcap 8vo, 3s.

*John Shea*

A MANUAL OF ANIMAL PHYSIOLOGY. With Appendix of Examination Questions. By JOHN SHEA, M.D., B.A. Lond. With numerous Engravings . . . . . Fcap 8vo, 5s. 6d.

—o—

VESTIGES of the NATURAL HISTORY OF CREATION. With 100 Engravings. Eleventh Edition . . . . . Post 8vo, 7s. 6d.

—o—

*J. Reay Greene*

TABLES OF ZOOLOGY: indicating the Tribes, Sub-Orders, Orders, and Higher Groups of the Animal Kingdom, for Students, Lecturers, and others. By J. REAY GREENE, M.D., Professor of Natural History in the Queen's University in Ireland. Three large sheets, 5s. the set; or, mounted on canvas, with roller and varnished . . . 12s. 6d.

\* \* \* These Tables have been carefully prepared in accordance with the present state of science, and with a view to remove the difficulties which arise from the various opinions held by different zoologists.

—o—

*Andrew Wilson*

THE STUDENT'S GUIDE TO ZOOLOGY: A Manual of the Principles of Zoological Science. By ANDREW WILSON, Author of "Elements of Zoology," and Lecturer on Zoology, Edinburgh. With Engravings . . . . . Fcap 8vo, 6s.

"It is alike lucid and well arranged."—*Med. Times and Gaz.*

"Really a good book, well and clearly written."—*Edin. Med. Jour.*

"A trustworthy guide."—*Lancet.*

"The illustrations are clear, and the whole work is elegant and compact."—*Med. Chir. Rev.*

—o—

*R. Dunglison*

MEDICAL LEXICON: A DICTIONARY OF MEDICAL SCIENCE. Containing a Concise Explanation of the various Subjects and Terms of Anatomy, Physiology, Pathology, Hygiene, Therapeutics, Pharmacology, Pharmacy, Surgery, Obstetrics, Medical Jurisprudence, and Dentistry, Notices of Climate and of Mineral Waters, Formulæ for Officinal, Empirical, and Dietetic Preparations; with the Accentuation and Etymology of the Terms, and the French and other Synonyms. By ROBLEY DUNGLISON, M.D. New Edition, by RICHARD J. DUNGLISON, M.D.

[Royal 8vo (1,130 pp.), 28s.

\* \* \* The object of the author from the outset has been to make the work an epitome of the existing condition of medical science. Starting with this view, the great demand which has existed for the work has enabled him, in repeated revisions, to augment its completeness and usefulness, until at length it has attained the position of a recognised and standard authority.

*R. G. Mayne and J. Mayne*

**MEDICAL VOCABULARY:** being an Explanation of all Names and Phrases used in the various departments of Medical Science and Practice, giving their Derivation, Meaning, Application, and Pronunciation. Fourth Edition . . . . . Fcap 8vo, 10s.

"We have referred to this work hundreds of times, and have always obtained the information we required . . . . Chemical, Botanical, and Pharmaceutical Terms are to be found on almost every page."—*Chemist and Druggist*.

—o—  
*G. Dawson*

**A MANUAL OF PHOTOGRAPHY.** By GEORGE DAWSON, M.A., Ph.D., Lecturer on Photography in King's College, London. Eighth Edition, with Engravings . . . . . Fcap 8vo, 5s. 6d.

"The new edition of this excellent manual, which is founded on and incorporates as much of Hardwich's 'Photographic Chemistry' as is valuable in the present further advanced stage of the art, retains its position as the best work on the subject for amateurs, as well as professionals. The many new methods and materials which are so frequently being introduced, make it essential that any book professing to keep up to the times must be frequently revised, and Dr. Dawson has in this work presented the subject in its most advanced position."—*Nature*, May 29, 1873.

—o—  
*Lake Price*

**A MANUAL OF PHOTOGRAPHIC MANIPULATION.** By LAKE PRICE. Second Edition, with numerous Engravings. [Crown 8vo, 6s. 6d.]

\* \* \* Amongst the Contents are the Practical Treatment of Portraits—Groups in the Studio—Landscapes—Groups in Open Air—Instantaneous Pictures—Animals—Architecture—Marine Subjects—Still Life—Copying of Pictures, Prints, Drawings, Manuscripts, Interiors—Stereoscopy in Microphotography, &c., and Notices of the last Inventions and Improvements in Lenses, Apparatus, &c.

"In these days, when nearly every intelligent person can, after a few weeks, master the manipulatory details of our art-science, attention to the artistic treatment of subjects is a matter for the serious consideration of the Photographer; and to those who desire to enter on this path, Mr. LAKE PRICE, in the volume before us, proves himself to be 'a guide, philosopher, and friend.'"—*The British Journal of Photography*.

—o—  
*C. Brooke*

**THE ELEMENTS OF NATURAL PHILOSOPHY.** By CHARLES BROOKE, M.B., M.A., F.R.S. Based on the Work of the late Dr. GOLDING BIRD. Sixth Edition, with 700 Engravings. [Fcap. 8vo, 12s. 6d.]

—o—  
*G. F. Rodwell*

**NOTES ON NATURAL PHILOSOPHY:** Lectures delivered at Guy's Hospital, by G. F. RODWELL, F.R.A.S., Science Master in Marlborough College. With 48 Engravings. [Fcap 8vo, 5s.]

"As an introductory text-book for this Examination [the Preliminary Scientific (M.B.) of the University of London], it is quite the best one we have seen . . . The 'Notes' chiefly consist of lucid and concise definitions, and everywhere bristle with the derivations of scientific terms."—*Nature*.  
"A well-arranged and carefully-written condensation of the leading facts and principles of the chief elements of Natural Philosophy."—*Chemical News*.



THE following CATALOGUES issued by Messrs CHURCHILL will be forwarded post free on application:

1. *Messrs Churchill's General List of nearly 600 works on Medicine, Surgery, Midwifery, Materia Medica, Hygiene, Anatomy, Physiology, Chemistry, &c., &c., with a complete Index to their Titles for easy reference. N.B. This List includes Nos. 2 and 3.*
2. *Selection from Messrs Churchill's General List, comprising all recent works published by them on the Art and Science of Medicine.*
3. *A Selected and Descriptive List of Messrs Churchill's works on Chemistry, Materia Medica, Pharmacy, Botany, Photography, The Microscope, and other branches of Science.*
4. *Messrs Churchill's Red-Letter List, giving the Titles of forthcoming New Works and New Editions.*  
[Published every October.]
5. *The Medical Intelligence, an Annual List of New Works and New Editions published by Messrs J. & A. Churchill, together with Particulars of the Periodicals issued from their House.*

\* [Sent at the commencement of each year to every Medical Practitioner in the United Kingdom whose name and address can be ascertained. A large number are also forwarded to the United States of America, Continental Europe, India, and the Colonies.]

MESSRS CHURCHILL have a special arrangement with MESSRS LINDSAY & BLAKISTON, OF PHILADELPHIA, in accordance with which that Firm acts as their Agents for the United States of America, either keeping in Stock most of Messrs CHURCHILL'S Books, or reprinting them on Terms advantageous to Authors. Many of the Works in this Catalogue may therefore be easily obtained in America.

